# Python API
# Concise Reference Guide
L-2016.06

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# PYTHON API CONCISE REFERENCE GUIDE

# INTRODUCTION

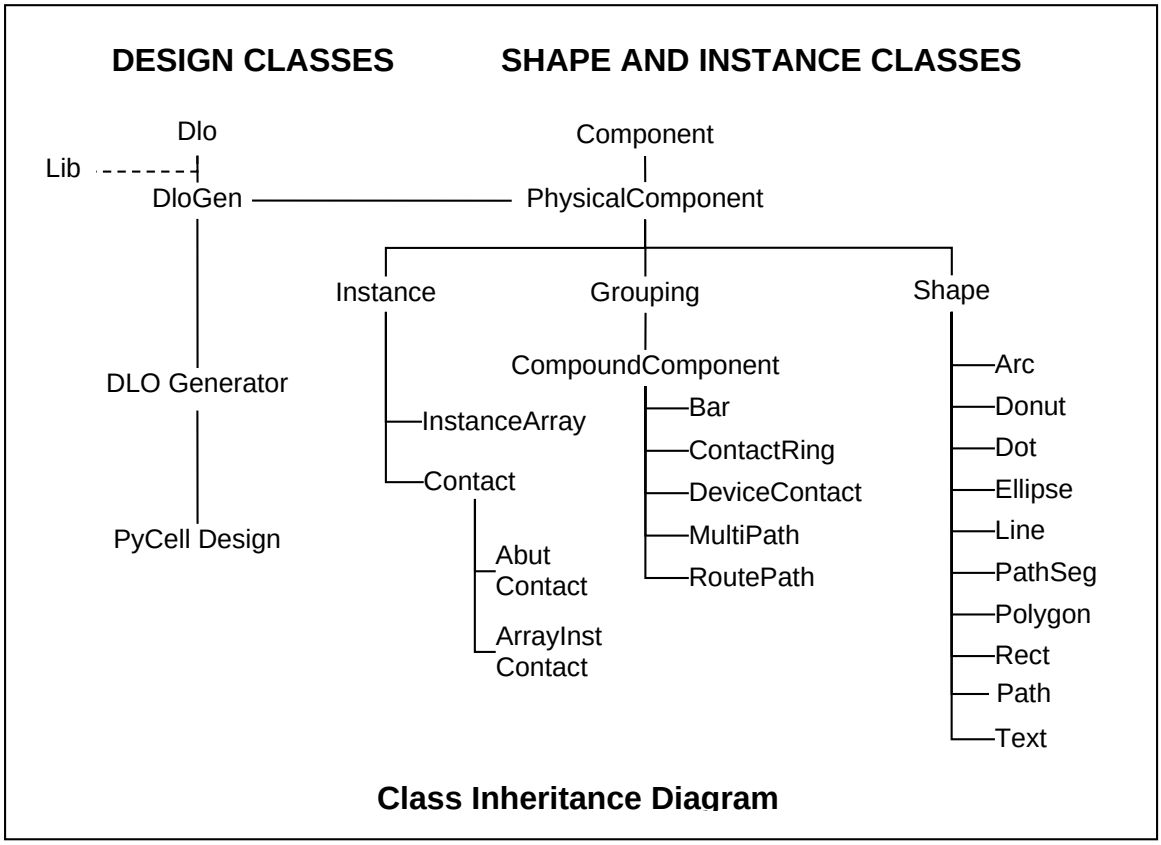
## Summary:

This guide provides a concise description of all of the Python API commands. While this guide is designed to be a handy quick reference to the full Python API, it is not meant to be a replacement for the much more in-depth reference material provided in the complete Python API documentation. Instead, this guide is meant to serve as a quick refresher, so that basic information about a certain class or method can be quickly located. This guide should be used in conjunction with the complete Python API Reference manual document.

## How to Use this Reference Guide:

This Reference Guide contains a section for each of the classes defined for the Python API. A brief description of the overall functionality of the class is given, along with very brief descriptions of each method defined for that class. These methods are listed in alphabetical order, except for any creation methods for the class, which are always listed at the beginning. Each class method description includes the listing of the parameter keywords and expected parameter types, along with a short description of the functionality of that method. The return value for each class method is also described. In addition, any attributes or properties for the class are briefly described.

## Class Organization:




**Class Inheritance Diagram**

**TECHNOLOGY CLASSES**

Layer
LayerMaterial
ShapeFilter, Grid
PhysicalRule, RuleProperty
Tech

**CONNECTIVITY CLASSES**

SignalType, TermType
Net, Pin, Term
InstPin, InstTerm
ShapeRef, Topology
RouteTarget

**BASIC GEOMETRIC CLASSES**

Point
Range, Segment
Box
Direction
Location
Orientation, Transform
PathStyle, GapStyle

**UTILITY CLASSES**

ParamArray, ParamSpecArray
PropSet, PointList
Log, Unique, NameMapper
Numeric, cFloat, AttrDict,
OrderedDict, ParamDictSpec, CDF, DPL,
Grid, SnapType, Fill, CrossOver, Marker
DrcSummary

## Class Methods:

# I. DESIGN CLASSES

The design classes include the Dlo, DloGen and Lib classes.

**Dlo**

Base class for DloGen and all design related classes. This is an abstract base class, which is only used for class derivation, and cannot be directly created. DLO is an acronym for “Dynamic Layout Object”.

**exists(**string *dloName***)**
returns True if the *dloName* Dlo design object exists, and False otherwise
**getLib**()
returns the open library associated with this Dlo
**getName**()
returns string containing the library name, cell name and view name for this Dlo
**getProps**()
returns PropSet Python dictionary-like object containing properties for this Dlo
**getTech**()
returns current Tech technology object associated with this Dlo design object
**getTermOrder**()
returns ordered terminal name list, which defines terminal connectivity by position
**getViewType**()
returns the view type associated with this Dlo design object
**isSubMaster**()
returns True if this Dlo design is a SubMaster design, and False otherwise
**isSuperMaster**()
returns True if this Dlo design is a SuperMaster design, and False otherwise
**save**()
saves this Dlo design using the library name, cell name and view name used when this Dlo object was created
**saveAs**(string *libName*, string *cellName*, string *viewName* = “”)
saves this Dlo design using the passed library name, cell name and view name
**setTermOrder**()
ordered list of terminal names defines terminal connectivity by position

**Attributes:**
**props** – returns any property-value pairs defined for this Dlo design object
**tech –** returns read-only Tech object associated with this Dlo design object

**DloGen**

Base class for all DLO design generators. This is an abstract base class, only used for class derivation, and cannot be directly created. The PyCell™ author must provide the virtual methods which actually create design layout for the parameterized cell.

**addPin**(string *pinName*, string *termName*, Box *box*, Layer *layer*)
**addPin**(string *pinName*, string *termName*, Box *box*, LayerList *layers*)
adds pin having specified name for the specified terminal to design represented by this DloGen object; creates geometries for pin on specified layers.
**addTerm**(string *name*, TermType *termType*=TermType.INPUT_OUTPUT)
adds a terminal with the specified name to this DloGen design object
**currentDloGen**()
returns current DloGen design object; used within non-DloGen derived classes
**dbu2uu**(int *value*)
returns user unit value corresponding to specified database unit value
**dbu2uuArea**(int *value*)
returns user unit value corresponding to specified square database unit value
**findComp**(string *name*="")
returns physical component having this *name* in current design
**findCompRef**(string *name*)
returns reference physical component having this *name* in current design
**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns bounding box for all physical components, using any specified layers
**getComp**(int *index*)
returns component in this DloGen object at the specified *index* value
**getComps**()
returns uniform list of all components and groupings in this DloGen object
**getLeafComps**()
returns uniform list of all leaf-level physical components in this DloGen object
**getNets**()
returns uniform list of all nets in this DloGen object
**getPins**()
returns uniform list of all pins in this DloGen object
**getTerms**()
returns uniform list of all terminals in this DloGen object
**makeCompName**(string *prefix*)
generates unique name for physical component within this DloGen design object
**makeGrouping**(string *name*='')
creates Grouping object containing all physical components in this DloGen object
**makeNetName**(string *prefix*)
generates unique name for net within this DloGen design object
**makePinName**(string *prefix*)
generates unique name for pin within this DloGen design object
**makeTermName**(string *prefix*)
generates unique name for terminal within this DloGen design object

**mirrorX**(Coord *yCoord*=0)
mirrors all physical components about the X coordinate axis
**mirrorY**(Coord *xCoord*=0)
mirrors all physical components about the Y coordinate axis
**moveBy**(Coord *dx*, Coord *dy*)
moves all physical components *dx* units in x-direction and *dy* units in y-direction
**moveTo**(Point *destination*, Location *handle*=Location.CENTER_CENTER,
ShapeFilter *filter*=ShapeFilter())
moves all physical components, so that specified *destination* point becomes handle point location for the bounding box for this physical component
**moveTowards**(Direction *dir*, Coord *distance*)
moves all physical components by specified distance in the specified direction
**rotate90**(Point *origin*=None)
rotates all physical components 90 degrees, in counter-clockwise direction
**rotate180**(Point *origin*=None)
rotates all physical components 180 degrees, in counter-clockwise direction
**rotate270**(Point *origin*=None)
rotates all physical components 270 degrees, in counter-clockwise direction
**setOrigin**(Point *origin*)
moves all physical components so that specified point becomes origin for design
**transform**(Transform *trans*)
applies the transform *trans* passed as a parameter to all physical components
**uu2dbu**(double *value*)
returns database unit value corresponding to specified user unit value
**uu2dbuArea**(double *value*)
returns database unit value corresponding to specified square user unit value
**withNewDlo**(object *callback*, string *lname*, string *cname*, string *vname*=None)
creates DLO for regression testing, using specified library, cell and view names

**Attributes:**

**AttrType** – display attribute type for this DloGen design object

**PyCell author provided methods**:

The parameterized cell author must provide methods which override these virtual methods defined for the DloGen base class

**defineParamSpecs**(ParamSpecArray *specs*)
defines parameters, default values and constraints for this parameterized cell
(must be defined using "@classmethod" or "@staticmethod" Python syntax)

**genLayout**()
generates actual physical layout for this parameterized cell

**genTopology**()
generates topology for the devices in this parameterized cell

**setupParams**(ParamArray *params*)
extracts the values for parameters entered by user of this parameterized cell

**sizeDevices**()
sizes the devices, before generating layout, for this parameterized cell

**VersionedDloGen**

This class is used to provide different versions of the Python source code for the same PyCell. The PyCell developer uses this class to create PyCells which use different versions of the source code to generate different versions of the layout for the PyCell. The PyCell user can then select a particular version of the Python source code by means of a special code versioning parameter for the PyCell.

Note that there are no methods for this class It is sufficient to derive the PyCell class from this class and use the built-in naming convention for versioned class names.

**Lib**

Class used to represent the OpenAccess library which is used to read and write PyCell design objects.

**attachTechLib**(string *techLibName*)
attaches Santana technology library to this Lib object
**close**(string *name*, string *path*)
closes library and destroys associated Lib object
**create**(string *name*, string *path*)
**create**(string *name*, string *path*)
creates library using specified name and path; raises exception if cannot be created
**definePcell**(object *cls*, string *cellName*, string *ViewName*='layout',
string *viewType*=None)
creates a parameterized cell in this library, using specified DloGen class
**getName**()
returns the name of this library
**getPath**()
returns the file path for this library
**getProps**(*cellName*=None, *viewName*=None, *readonly*=True)
returns PropSet Python dictionary-like object containing properties for this library; if *cellName* and/or *viewName* is set, then cell or cell view properties are returned.
**getTech**(*cnTechVersion*=None)
returns Santana Tech object associated with this library
**getTechFilePath**()
returns file path for the current Santana technology file attached to this library
**getTechLibName**()
returns name of current Santana technology library attached to this library
**installTechFile**(string *techFilePath*, Bool *withCoreDlos*=True,
Bool *forceBinary*=False, Bool *createTechDB*=True,
string *displayFilePath*=None)
copies technology information from Santana technology file into this library
**loadPcells**(string *cpkgID*)
loads parameterized cells stored in package into this library
**open**(string *name*, string *path*='')
opens library using specified name and path; raises exception if cannot be opened.
**updatePcell**(string *cellName*, string *viewName* = 'layout')
updates existing parameterized cell in this library, using current bindings

**Attributes:**
**props** – returns any property-value pairs defined for this Lib object
**tech** – returns current technology object for this library

# II. SHAPE AND INSTANCE CLASSES

The shape and instance classes represent all of the shapes and components which can be manufactured in a chip layout. In addition to the basic Shape class objects consisting of a single component drawn on a single layer, the Instance and Grouping classes provide multiple component layout objects which are drawn on multiple layers. These classes include higher-level objects such as contacts, bars, multi-paths, routes and contact rings.

**PhysicalComponent**

The base class from which all physical components and shapes are derived. This is an abstract base class, which is only used for class derivation, and cannot be directly created.

**abut**(Direction *dir*, PhysicalComponent *refComp*, ShapeFilter *filter*,
Bool *align*=True, ShapeFilter *refFilter*=None)
moves physical component in the specified direction, until its bounding box just touches the bounding box for the specified *refComp* physical component

**alignEdge**(Direction *dir*, PhysicalComponent *refComp*, Direction *refDir*=None,
ShapeFilter *filter*=ShapeFilter(), ShapeFilter *refFilter*=None,
Coord *offset*=None)
aligns edges of bounding boxes of these two physical components, using the specified directions to perform this one-dimensional alignment operation

**alignEdgeToPoint**(Direction *dir*, Point *point*, ShapeFilter *filter*=ShapeFilter())
aligns edge of bounding box of physical component to specified *point*

**alignLocation**(Location *loc*, PhysicalComponent *refComp*,
Location *refLoc*=None, ShapeFilter *filter*=ShapeFilter(),
ShapeFilter *refFilter*=None, Point *offset*=None)
aligns locations of bounding boxes of these two physical components, using the specified locations to perform this two-dimensional alignment operation

**alignLocationToPoint**(Location *loc*, Point *point*, ShapeFilter *filter*=ShapeFilter())
aligns location of bounding box of physical component to specified *point*

**clone**()
virtual method to be overridden in derived class, to return cloned copy

**destroy**()
destroys this physical component, as well as underlying OpenAccess object

**find**(string *name*='')
returns physical component having specified name in current design

**fgAbut**(Direction *dir*, PhysicalComponent *refComp*, LayerList *abutLayers*,
ShapeFilter *filter*=ShapeFilter(), PhysicalComponent *env*=None,
Bool *align*=True, ShapeFilter *refFilter*=None, dict *options*=None)
combines functionality of **fgPlace**() and **fgFill**() methods; this component is placed next to *refComp* component, abutting them on the *abutLayers* list of layers. New shapes will be created to fill any gaps between components on these layers.

**fgAddEnclosingPolygon**(Layer *layer*, ShapeFilter *filter*=ShapeFilter(), PhysicalComponent *env*=None)
creates enclosing polygon on the specified layer, by using minimum enclosure technology design rules. Note that non-rectangular polygons can be generated.

**fgAnd**(PhysicalComponent *comp*, Layer *resultLayer*, ShapeFilter *filter*=ShapeFilter(), ShapeFilter *compFilter*=None)
performs logical and operation for polygon shapes contained in each physical component, on specified layers; shapes are generated on the *resultLayer*.

**fgDeriveLayer**(string *derivationScript*, Layer *layer*, ShapeFilter *filter*=ShapeFilter())
runs DRC program to check DRC correctness for this physical component, using design rules in technology file attached to current design.

**fgEnclose**(LayerList layers, ShapeFilter filter=ShapeFilter(), dict options=None)
creates rectangles that enclose the physical component on every layer in the given layer list. All minimum enclose design rules are considered to produce the DRC correct set of enclosing rectangles.

**fgExtend**(PhysicalComponent comp, ShapeFilter filter=ShapeFilter(), dict options=None)
for a single Rect object or a grouping of Rect objects, extends the rectangles in order to satisfy all minimum extension design rules between the rectangles and other shapes overlapping them.

**fgFill**(PhysicalComponent *comp*, Layer *layer*, Direction *dir*, Coord *divider*)
performs DRC-correct fill operation between two components, in given direction; *divider* specifies dividing line between two components for this fill operation.

**fgMerge**(Layer *resultLayer*=None, ShapeFilter *filter*=None)
merges all polygon shapes contained on single layer for the physical component; shapes are generated on the *resultLayer*.

**fgMinSpacing**(Direction *dir*, PhysicalComponent *refComp*, ShapeFilter *filter*=ShapeFilter(), PhysicalComponent *env*=None, Bool *align*=True, ShapeFilter *refFilter*=None, dict *options*=None)
returns minimum “DRC clean” distance between physical components

**fgNot**(PhysicalComponent *comp*, Layer *resultLayer*, ShapeFilter *filter*=ShapeFilter(), ShapeFilter *compFilter*=None)
performs logical not operation for polygon shapes contained in each physical component, on specified layers; shapes are generated on the *resultLayer*.

**fgOr**(PhysicalComponent *comp*, Layer *resultLayer*, ShapeFilter *filter*=ShapeFilter(), ShapeFilter *compFilter*=None)
performs logical or operation for polygon shapes contained in each physical component, on specified layers; shapes are generated on the *resultLayer*.

**fgPlace**(Direction *dir*, PhysicalComponent *refComp*, ShapeFilter *filter*=ShapeFilter(), PhysicalComponent *env*=None, Bool *align*=True, ShapeFilter *refFilter*=None, dict *options*=None)
performs “smart placement” of physical component, by moving it in the specified direction, such that it has minimal distance spacing from the *refComp* physical component. This spacing is determined from current set of technology design rules.

**fgSize**(ShapeFilter *filter*, Coord *sizeValue*, Layer *resultLayer*)
expands or shrinks polygon shapes contained in *comp* physical component,

based on value of *sizeValue* parameter; shapes are generated on the *resultLayer*.

**fgXor**(PhysicalComponent *comp*, Layer *resultLayer*,
ShapeFilter *filter*=ShapeFilter(), ShapeFilter *compFilte*r=None)
performs logical exclusive-or operation for polygon shapes contained in each physical component, on specified layers; shapes are generated on the *resultLayer*.

**getBBox**(ShapeFilter filter=ShapeFilter())
returns bounding box for this physical component, using any specified layers

**getCompOwner**()
returns owner of this physical component; by default, this is current DloGen object.

**getDlo**()
returns Dlo or DloGen design object which contains this physical component

**getName**()
returns name for this physical component

**getProps**()
returns PropSet Python dictionary-like object containing properties for this object

**getSpacing**(Direction *dir*, PhysicalComponent *refComp*,
ShapeFilter *filter*=ShapeFilter(), ShapeFilter *refFilter* = None)
uses bounding boxes to calculate current distance between this physical component and *refComp* physical component in the specified *dir* direction.

**makeArray**(Coord *dX*, Coord *dY*, unsigned *numRows*,
unsigned *numCols*, *baseName*='', *name*='')
creates array of components, as *numRows* rows by *numCols* columns; *dX* and *dY* specify spacing, while *baseName* is used to name components

**mirrorX**(Coord *yCoord*=0)
mirrors physical component about the X coordinate axis

**mirrorY**(Coord *xCoord*=0)
mirrors physical component about the Y coordinate axis

**moveBy**(Coord *dx*, Coord *dy*)
moves physical component *dx* units in x-direction and *dy* units in y-direction

**moveTo**(Coord *x*, Coord *y*, Location *handle*=Location.CENTER_CENTER,
ShapeFilter *filter*=ShapeFilter())
moves physical component, so that specified point coordinates become the *handle* point location for the bounding box of this physical component

**moveTowards**(Direction *dir*, Coord *d*)
moves physical component by specified distance in the specified direction

**overlaps**(Box *box*)
returns True if bounding box for this physical component overlaps specified box

**place**(Direction *dir*, PhysicalComponent *refComp*, Coord *distance*,
ShapeFilter *filter*=ShapeFilter(), Bool *align*=True, ShapeFilter *refFilter*=None)
performs explicit placement of physical component, by moving it in the specified direction, until it is the specified distance from the *refComp* physical component.

**rotate90**(Point *origin*=None)
rotates physical component 90 degrees in counter-clockwise direction

**rotate180**(Point *origin*=None)

rotates physical component 180 degrees in counter-clockwise direction

**rotate270**(Point *origin*=None)
rotates physical component 270 degrees in counter-clockwise direction

**setName**(string *name*)
sets name for this physical component

**snap**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps to manufacturing grid points on the layers specified by the *filter* parameter; ensures that components are aligned to manufacturing grid points.

**snapX**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps X coordinate of lower-left vertex point of bounding box for this component

**snapY**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps Y coordinate of lower-left vertex point of bounding box for this component

**snapTowards**(Grid *grid*, Direction *dir*, ShapeFilter *filter*=ShapeFilter())
snaps lower-left vertex point of bounding box for component in the *dir* direction

**transform**(Transform *trans*)
applies the transform *trans* passed as a parameter to this physical component

**Attribute:**

**props** – returns any property-value pairs defined for this PhysicalComponent

## Instance

The base class for all instances of DLO design objects.

**Instance**(string *dloName*, *params*=None, NodeSpec *nodeSpec*=None,
string *name*='', Transform *trans*=None)
creates instance of DLO master, using specified parameters and instance name

**clone**()
returns a cloned copy of this Instance object

**find**(string *name*='')
returns Instance object having specified name in current design

**findInstPin**(string *name*='')
returns instance pin having specified name for this Instance object

**findInstTerm**(string *name*='')
returns instance terminal having specified name for this Instance object

**flatten**()
flattens this Instance to primitive shapes, and returns them as a Grouping

**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns the bounding box for this Instance, using layers specified in *filter* parameter

**getDefaultParams**(ParamArray *params*=None)
returns array of default parameters used when this Instance object was created

**getDloName**()
returns master design name, as string "<libName>/<cellName>/<viewName>"

**getInstPins**()
returns list of all instance pins for this instance

**getInstTerms**()

returns list of all instance terminals for this instance

**getMaster**()
returns the master design object used to create this Instance object

**getName**()
returns the name of this Instance object

**getOrientation**()
returns Orientation object for this instance

**getOrigin**()
returns the point which is the origin location for this Instance object

**getCompRefs**()
returns uniform list of all physical component reference ojects inside this Instance

**getParams**(ParamArray *params*=None, Bool *all*=True)
returns array of explicit parameters used when this Instance object was created

**getParamSpecs**()
returns parameter specifications used when this Instance object was created

**getTransform**()
returns Transform object for this Instance object

**setConnectivity**(self, NodeSpec *nodeSpec* bool strict=True)
Defines connectivity by specifying connections between terminals and nets. The *nodeSpec* parameter can be None (for no connectivity), Python dictionary associating nets with instance terminals, list of nets, or a single net. When the optional parameter strict is set to False, NodeSpec does not have to specify nets for all terms.

**setMaster**(string *libName*="", string *viewName*="", string *cellName*="")
sets the master design for this Instance object

**setName**(string *name*)
sets the name for this Instance object

**setOrientation**(Orientation *orient*)
sets Orientation object for this instance

**setOrigin**(Point *point*)
sets specified point to be origin location for this Instance object

**setParams**(ParamArray *params*)
set the parameter values for this Instance object

**setTransform**(Transform *trans*)
sets Transform object for this Instance object

**Attribute:**

**name** – returns name for this Instance object (settable attribute)

**AttrType** – display attribute type for this Instance object

**InstanceArray**

The InstanceArray class is derived from the base Instance class, and used to represent an array of instances of a single DLO master design. This class is typically used for memory efficiency purposes. For example, it can be used to represent an array of individual memory cells in a physical layout design.

**InstanceArray**(string *dloName*, Coord *dX*, Coord *dY*, unsigned int *numRows*,
unsigned int *numCols*, ParamArray *params*=None,
NodeSpec *nodeSpec*=None, string *name*=’’, Transform *trans*=None)
creates an array of instances of this DLO master, using the specified parameters, number of rows and columns, and the dX and dY array spacing between instances

**clone**()
returns a cloned copy of this InstanceArray object

**find**(string *name*=’’)
returns InstanceArray object having specified name in current design

**flatten**()
flattens this InstanceArray to primitive shapes, and returns them as a Grouping

**getDX**()
returns offset spacing between columns in the X direction

**getDY**()
returns offset spacing between rows in the Y direction

**getMemberBBox**(unsigned int *row*, unsigned int *col*,
ShapeFilter *filter* = ShapeFilter())
returns the bounding box for instance at specified row and column in array; if ShapeFilter is used, only those layers are used in bounding box calculations

**getMemberRefs**()
returns list of members of this InstanceArray being used as reference objects

**getMemberTransform**(unsigned int *row*, unsigned int *col*)
returns transform for instance at specified row and column in array

**getNumCols**()
returns number of columns for this instance array

**getNumRows**()
returns number of rows for this instance array

**setDX**(Coord *dX*)
sets offset spacing between columns in the X direction

**setDY**(Coord *dY*)
sets offset spacing between rows in the Y direction

**setName**(string *name*)
sets the name for this instance array

**setNumCols**()
sets number of columns for this instance array

**setNumRows**()
sets number of rows for this instance array

**Attribute:**

**name** – returns name for this Instance object (settable attribute)

## Contact

The Contact class provides a connection between specified interconnect layers. The Contact DLO is directly derived from the Instance class. Any such Contact objects will be constructed to meet DRC and electrical design rules. Note that the Contact object will be constructed using one or more cuts, which are used to improve manufacturing yield; the minimum number of cuts can be set through the "setMinCuts()" class method.

**Contact**(Layer *layer1*, Layer *layer2*, NodeSpec *nodeSpec*=None,
Direction *routeDir1*=None, Direction *routeDir2*=None,
Point *point1*=INVALID, Point *point2*=INVALID,
Direction *anchor*=CENTER, LayerList *addLayers*=None, string *name*='')
creates a Contact object which connects the two specified layers. The specified points are used to define the reference box for the Contact object, while *addLayers* is used to specify any additional layers to be used to construct the Contact.

**clone**()
returns a cloned copy of this Contact object

**getLayer1**()
returns the first connection layer for this contact

**getLayer2**()
returns the second connection layer for this contact

**getLayers**()
returns the lists of routing, interconnect and additional layers for this contact

**getNumCuts**()
returns the number of cuts for this contact

**getNumHVCuts**()
returns the number of horizontal and vertical cuts for this contact

**getRefBox**()
returns the reference box for this contact

**setMinCuts**(unsigned int *minCuts*)
specifies minimum number of cuts to be generated for this Contact object; note that the contact size will automatically be adjusted to accommodate this number of cuts.

**stretch**(Box *refBox*)
grow or shrink this contact until length and width match specified box dimensions

**stretchTo**(Direction *dir*, Point *point*)
grow or shrink this contact in specified direction until point is collinear with side

**stretchToCoord**(Direction *dir*, Coord *value*)
grow or shrink this contact, by defining reference box in specified direction

## AbutContact

The AbutContact class provides a specialized contact, which is used to abut two contacts. This AbutContact class is directly derived from the Contact class. In addition to the methods inherited from the base Contact class, an additional method is provided to control the via spacing between the two abutting contacts.

**AbutContact**(Layer *layer1*, Layer *layer2*, NodeSpec *nodeSpec*=None,
Direction *routeDir1*=None, Direction *routeDir2*=None,
Point *point1*=INVALID, Point *point2*=INVALID,
Direction *anchor*=Direction.CENTER, LayerList *addLayers*=None,
string *name*='', Direction *abutDir*=Direction.NONE,
int *abutViaSpaceFactor*=1, Bool *symAddLayer*=False)
creates an AbutContact object which can be used to abut two contacts. The *abutDir* specifies the direction in which this contact should be abutted with another contact.

**clone**()
returns cloned copy of this AbutContact object

**setAbutViaSpaceFactor**(int *abutViaSpaceFactor*)
sets via spacing factor as integer multiple of one half via spacing design rule value

**ArrayInstContact**

The ArrayInstContact class provides a specialized contact, which only differs from the base Contact class as regards the implementation of cuts. The cuts for this contact are implemented using the InstanceArray class, rather than as separate rectangles. This is more memory efficient for large contacts, which require a larger number of cuts.

**ArrayInstContact**(Layer *layer1*, Layer *layer2*, NodeSpec *nodeSpec*=None,
Direction *routeDir1*=None, Direction *routeDir2*=None,
Point *point1*=INVALID, Point *point2*=INVALID,
Direction *anchor*=CENTER, LayerList *addLayers*=None,
string *name*='')
creates an ArrayInstContact object; note that this creation method has exactly the same parameters as the base Contact class.

**clone**()
returns cloned copy of this ArrayInstContact object

**Grouping**

The Grouping class provides the ability to group together one or more physical components into a logical grouping. The methods for this class provide convenient layout manipulation operations, which can be applied to all components in a single operation.

**Grouping**(string *name*='', *components*=None)
creates Grouping object with given name; *components* parameter specifies physical component or list of components which should be added to this new grouping.

**add**(*components*)
add physical component or list of physical components to this Grouping object

**clone**()
returns a cloned copy of this Grouping object

**destroy**()
base class method which destroys container object for this Grouping object

**find**(string *name*="")
returns Grouping object having this *name* in the current DloGen design
**flatten()**
recursively flattens this Grouping object to lowest-level physical components
**getBBox**(ShapeFilter *filter*)
returns bounding box for this Grouping object, using any specified layers
**getComp**(int *index*)
returns component in this grouping at the specified *index* value
**getComps**()
returns uniform list of all members for this Grouping object
**getLeafComps**()
returns uniform list of all leaf-level physical components in this grouping
**getName**()
returns name for this Grouping object
**isPersistent**()
returns True if this Grouping object is persistent and False otherwise
**makePersistent**(Bool *persistent*)
makes this Grouping object persistent in the OpenAccess database
**mirrorX**(Coord *yCoord*=0)
mirrors all physical components about X-coordinate axis
**mirrorY**(Coord *xCoord*=0)
mirrors all physical components about Y-coordinate axis
**moveBy**(Coord *dx*, Coord *dy*)
moves all physical components *dx* units in x-direction and *dy* units in y-direction
**moveTo**(Point *destination*, Location *handle*=Location.CENTER_CENTER,
ShapeFilter *filter*=ShapeFilter())
moves all physical components in the specified direction, so that specified point becomes the handle point for the bounding box of this Grouping object.
**moveTowards**(Direction *dir*, Coord *distance*)
moves all physical components by specified distance in the specified direction
**remove**(*components*)
remove physical component or list of components from this grouping
**rotate90**(Point *origin*=None)
rotates all physical components by 90 degrees, in counter-clockwise direction
**rotate180**(Point *origin*=None)
rotates all physical components by 180 degrees, in counter-clockwise direction
**rotate270**(Point *origin*=None)
rotates all physical components by 270 degrees, in counter-clockwise direction
**setName**(string *name*)
sets the name for this grouping
**transform**(Transform *trans*)
applies the transform *trans* passed as a parameter to all physical components
**ungroup**(Grouping *owner*=None, Bool *all*=False)
transfers all grouping members to *owner* grouping (or current design, if *owner* is None), and then destroys this grouping; if all is True, all intermediate-level groupings within this grouping are also ungrouped.

**Attribute:**

**name** – returns the name for this Grouping object (settable attribute)

## Compound Component

The CompoundComponent class is derived from the Grouping class, and provides the ability to group together one or more physical components into a compound object. This class provides a locking mechanism for membership and member operations. Members can only be added or removed or modified when the compound component is unlocked.

**CompoundComponent**(string *name*, *components*=None)
creates compound component object with given name; *components* parameter specifies components which should be added to this new compound component.

**clone**()
returns a cloned copy of this CompoundComponent object

**destroy**()
destroys the CompoundComponent, as well as all of its members

**flatten()**
flattens this CompoundComponent to lowest-level physical components

**isLocked**()
returns True if this CompoundComponent is locked and False otherwise

**lock**()
locks this CompoundComnponent, so that members cannot be modified

**mirrorX**(Coord *yCoord*=0)
temporarily unlocks this CompoundComponent, and then mirrors all physical components about X-coordinate axis

**mirrorY**(Coord *xCoord*=0)
temporarily unlocks this CompoundComponent, and then mirrors all physical components about Y-coordinate axis

**moveBy**(Coord *dx*, Coord *dy*)
temporarily unlocks this CompoundComponent, and then moves all physical components *dx* units in x-direction and *dy* units in y-direction

**moveTo**(Point *destination*, Location *handle*=Location.CENTER_CENTER,
ShapeFilter *filter*=ShapeFilter())
temporarily unlocks this CompoundComponent, and then moves all physical components so that specified point *destination* then becomes the *handle* point for the bounding box of this Grouping object.

**moveTowards**(Direction *dir*, Coord *distance*)
temporarily unlocks this CompoundComponent, and then moves all physical components by specified distance in the specified direction

**rotate90**(Point *origin*=None)
temporarily unlocks this CompoundComponent, and then rotates all physical components by 90 degrees, in counter-clockwise direction

**rotate180**(Point *origin*=None)
temporarily unlocks this CompoundComponent, and then rotates all physical

components by 180 degrees, in counter-clockwise direction

**rotate270**(Point *origin*=None)
temporarily unlocks this CompoundComponent, and then rotates all physical components by 270 degrees, in counter-clockwise direction

**snap**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
temporarily unlocks this CompoundComponent, and then snaps to grid points

**snapX**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
temporarily unlocks this CompoundComponent, and then snaps X-coordinate

**snapY**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
temporarily unlocks this CompoundComponent, and then snaps Y-coordinate

**snapTowards**(Grid *grid*, Direction *dir*, ShapeFilter *filter*=ShapeFilter())
temporarily unlocks this CompoundComponent, and then snaps in the *dir* direction

**transform**(Transform *trans*)
temporarily unlocks this CompoundComponent, and then applies *trans* transform to all physical components

**ungroup**()
destroys CompoundComponent, and returns members to the DloGen design object

**unlock**()
unlocks this CompoundComponent, so that members can be modified

## Bar

The Bar class provides simple routing on a single layer or between two different layers. This is a horizontal or vertical route, to which vertical or horizontal connections can be made. Contacts can be added to make connections between different layers.

**Bar**(Layer *layer*, Direction *dir*, string *node*, Point *point1*=INVALID, Point *point2*=INVALID, Direction *anchor*=SOUTH_WEST, string *name*)
creates Bar object on the specified layer, using the specified anchor direction

**addContact**(Layer *layer*, Point *point1*, Point *point2*=INVALID, Direction *anchor*=CENTER, Direction *routeDir*=NONE)
adds a new contact to this Bar object, using specified points to define reference box

**clearContacts**()
removes all of the contacts associated with this Bar object

**clone**()
returns a cloned copy of this Bar object

**destroy**()
destroys all of the components (contacts and rectangle) for this Bar object

**extendTo**(Point *point*)
extends this Bar until end of Bar is collinear with specified point

**getContacts**()
returns uniform list of all contacts associated with this Bar object

**getDirection**()
returns direction for this Bar object (either NORTH_SOUTH or EAST_WEST)

**getLayer**()
returns layer on which this Bar object is defined

**getRect**()
returns Route rectangle for this Bar object
**getRoutePathIntersectBox**(RouteTarget *fromTarg*)
returns box which is intersection of this Bar with generate RoutePath object
**stretchTo**(Point *point*)
stretches (or shrinks) this Bar until end of Bar is collinear with specified point
**stretchToCoord**(Direction *dir*, Coord *value*)
stretches Bar in the *dir* direction, until edge of Bar has specified coordinate *value*
**trim**()
trims Bar object to size required to connect all associated contacts

**ContactRing**

The ContactRing class creates a guard ring, which can be used to isolate a set of devices in a design from external noise and/or to prevent latch-up. This guard ring consists of four abutting contacts, along with an optional fill rectangle. An optional gap between the top and left contacts can also be generated, when the contact ring is created.

**ContactRing**(Layer *layer1*, Layer *layer2*, string *node*='', LayerList *addLayers*=None,
Coord *width*=0, Coord *gap*=0, LayerList *fillLayers*=None,
String name='', DirectionList *locations*=None,
ShapeFilter *ruleFilter*=ShapeFilter(), Box *encloseBox*=None,
PhysicalComponent *encloseComp*=None, Bool *overlapContact*=False,
Bool *fillToBoundary*=False, dict *options*=None)
creates ContactRing object using *layer* and *width* parameters to define four contacts which make up this ContactRing object. Note that this contact ring can be automatically placed to enclose all shapes and instances in the current design, or can be explicitly placed using the *encloseBox* or *encloseComp* parameters.
**chop**(Box *cutBox*, LayerList *cutLayers*, LayerList *mendLayers*=None,
Layer *joinLayer*=None)
cuts out interconnect layers specified by *cutLayers* parameter, for the section of contact ring defined by *cutBox* parameter. The optional *mendLayers* and *joinLayer* parameters are used to restore connectivity after this chopping operation.
**clone**()
returns a cloned copy of this ContactRing object
**destroy**()
destroys this ContactRing object, including all contacts and fill rectangle
**getContact**(Direction *dir*)
returns the contact for the specified direction (NORTH, SOUTH, EAST, WEST)

DeviceContact

The DeviceContact class provides a connection between adjacent interconnect layers. The DeviceContact class is directly derived from the CompoundComponent class, and is used for device construction (versus the Contact class, which is best suited for routing). This DeviceCntact can be constructed to meet DRC and electrical design rules, or the designer can easily override these design rule values. This approach provides flexibility.

**DeviceContact**(Layer *layer1*, Layer *layer2*, Box *box*,
GapStyle *gapStyle*=GapStyle.MIN_CENTER,

ulist[int] *minCuts*=None, ulist[float] *layer1Ext*=None,
ulist[float] layer2Ext=None, ulist[float] viaSpace=None,
ulist[float] viaSize=None, Direction *routeDir1*=None,
Direction *routeDir2*=None, string *name*=’’)

creates a DeviceContact object which connects the two specified layers. The *box* parameter specifies the area to be filled by the *layer1* rectangle. The *layer1Ext*, *layer2Ext*, *viaSpace* and *viaSize* parameters can be used to override design rule values. Otherwise, applicable design rules are used to construct this DeviceContact.

**clone**()
returns a cloned copy of this DeviceContact object

**getLayer1**()
returns the first connection layer for this device contact

**getLayer2**()
returns the second connection layer for this device contact

**getNumHVCuts**()
returns the number of horizontal and vertical cuts for this device contact

**getRect1**()
returns the rectangle defined for the first interconnect layer

**getRect2**()
returns the rectangle defined for the second interconnect layer

**getViaBBox**()
returns bounding box of the via cuts for this device contact

**getViaLayer**()
returns via layer for this device contact

**stretch**(Layer *layer*, Box *box*)
stretches rectangle on *layer* until length and width match specified box dimensions

**stretchToCoord**(Layer *layer*, Direction *dir*, Coord *value*)
stretches rectangle on *layer* in specified direction *dir* until aligned with *value*

**stretchToPoint**(Layer *layer*, Direction *dir*, Point *point*)
stretches rectangle on *layer* in specified direction *dir* until aligned with *point*

## MultiPath

The MultiPath class provides the ability to group together multiple path objects. Additional subpath objects can be generated based upon the original master path object.

**MultiPath**(Layer *layer*, PointList *points*, Coord *width*,
Direction *justify*=EAST_WEST, Coord *sep*=0,
PathStyle *style*=PathStyle.TRUNCATE, Coord *beginExt*=0,
Coord *endExt*=0, Bool *choppable*=True, ulist[Box] *chopBoxes*=None,
string *node*=“”, string *masterName*=“”, string *name*= “”)
creates MultiPath object, using the specified values to create a Path object, based upon the master path, which is added to this newly created MultiPath object.

**clone**()
returns a cloned copy of this MultiPath object

**createEnclosureSubpath**(Layer *layer*, Coord *enclosure=0,*
Coord *beginEncl*=None, Coord *endEncl*=None,

Bool *choppable*=True, string *node*="", string *name*="")

adds a new Path object to this MultiPath, defined by specified enclosure values

**createOffsetSubpath**(Layer *layer*, Coord *width*,
Direction *justify*=EAST_WEST, Coord *sep*=0,
Coord *beginOffset*=0, Coord *endOffset*=0,
Bool *choppable*=True, string *node*="", string *name*="")

adds a new Path object to this MultiPath, defined by specified justification and separation values

**createSubrectangles**(Layer *layer*, Coord *width*=0, Coord *length*=0, Coord *space*=0,
GapStyle *gapStyle*=MINIMUM,
Direction *justify*=EAST_WEST, Coord *sep*=0,
Coord *beginOffset*=None, Coord *endOffset*=None,
Bool *choppable*=True, string *node*="" string *name*="")

creates a field of subrectangles on the specified *layer* for this MultiPath

**destroy**()

destroys this MultiPath object, including all path rectangles

**genJustifyPathPoints** (PointList *refPoints*, Coord *width*=0,
Direction *justify*= EAST_WEST, Coord *sep*=0,
Coord *subWidth*=0, Coord *beginOffset*=0, Coord *endOffset*=0)

returns justified point list constructed from *refPoints* list of reference points

**getChoppedSubpathPointLists**(*name*="")

returns list of points for chopped subpath or master path specified by *name*

**getMasterPathName**()

returns name assigned to master path for this MultiPath

**getSubpathPoints**(*name*="")

returns list of points for subpath or master path specified by *name*

**mirrorX**(Coord *yCoord* = 0)

mirrors all components in this MultiPath about the X coordinate axis

**mirrorY**(Coord *xCoord* = 0)

mirrors all components in this MultiPath about the Y coordinate axis

**moveBy**(Coord *dx*, Coord *dy*)

moves all components *dx* units in x-direction and *dy* units in y-direction

**moveTo**(Point *destination*, Location *handle*=Location.CENTER_CENTER,
ShapeFilter *filter*=ShapeFilter())

moves all components so that specified point *destination* becomes the *handle* point for the bounding box of this MultiPath object

**moveTowards**(Direction *dir*, Coord *distance*)

moves all components by specified distance in the specified direction

**rotate90**(Point *origin*=None)

rotates all components by 90 degrees in a counter-clockwise direction

**rotate180**(Point *origin*=None)

rotates all components by 180 degrees in a counter-clockwise direction

**rotate270**(Point *origin*=None)

rotates all components by 270 degrees in a counter-clockwise direction

**snap**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())

snaps both X and Y coordinates of the lower-left vertex point of the bounding box

for this MultiPath object to the grid points defined by the *grid* parameter.

**snapX**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps only X coordinate of the lower-left vertex point of the bounding box for this MultiPath object to grid points defined by the *grid* parameter.

**snapY**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps only Y coordinate of the lower-left vertex point of the bounding box for this MultiPath object to grid points defined by the *grid* parameter.

**snapTowards**(Grid *grid*, Direction *dir*, ShapeFilter *filter*=ShapeFilter())
snaps coordinates of the lower-left vertex point of the bounding box for this MultiPath object to the grid points defined by the *grid* parameter.

**transform**(Transform *trans*)
applies transform *trans* to all of the components in this MultiPath object

## RoutePath

The RoutePath class is used to make connections between two different shapes within a design. These connections include straight-line routes, LShapes ZShape and CShape routes. For the straight-line routes, connections can also be made to bars. Note that most class methods are static, so construction is not usually required.

**Connect**(RouteTarget *fromTarg*, RouteTarget *toTarg*, Layer *layer*=None, Coord *width*=0, Bool *genContact*=True, string *name*='')
first attempts to generate straight-line route; if this is not successful, then ZShape route will be generated, if this is not successful, then LShape route will be used.

**CShape**(RouteTarget *fromTarg*, RouteTarget *toTarg*, Layer *layer*=None, Point *position*=None, Direction *dir*=EAST, Coord *width*=0, string *name*='')
generates CShape route between route targets, using preferred routing layer

F**lightLine**(RouteTarget *fromTarg*, RouteTarget *toTarg*, Layer *layer*=None, string *name*='')
generates flight line between route targets on specified *layer*, or FlightLine layer

**LShape**(RouteTarget *fromTarg*, RouteTarget *toTarg*, Layer *layer*=None, Direction *dir*=EAST_WEST, Coord *width*=0, string *name*='')
generates LShape route between route targets, using preferred routing layer

**StraightLine**(RouteTarget *fromTarg*, RouteTarget *toTarg*, Layer *layer*=None, Coord *width*=0, Bool *genContact*=True, string *name*='')
generates straight-line route between specified pins, using preferred routing layer

**StraightLineToBar**(RouteTarget *fromTarg*, Bar *bar*, Layer *layer*=None, Coord *width*=0, Bool *genContact*=True, string *name*='')
generates straight-line route between pin and bar, using preferred routing layer

**ZShape**(RouteTarget *fromTarg*, RouteTarget *toTarg*, Layer *layer*=None, Point *position*=None, Direction *dir*=None, Coord *width*=0, string *name*='')
generates ZShape route between specified pins, using preferred routing layer

**checkLayerWidth**(Layer *layer*, Coord *width*)
compares *width* parameter to minimum width DRC rule for given *layer* parameter

**clone**()

returns cloned copy of this RoutePath object

**destroy**()
destroys this RoutePath object, including all route rectangles and contacts

**findAdjacentInterconnectLayer**(LayerList *layers*,
Layer *bestLayer*, Bool *refAbove*=True)
returns closest interconnect layer to specified layer in list of layers

**getLayer**()
returns layer which is being as routing layer

**Boundary**

The base class from which Place and Route boundary objects are derived. This is an abstract base class, only used for class derivation, which cannot be directly created.

**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns bounding box for this Boundary; note that since Boundary has no layers, any layers specified in the *filter* ShapeFilter object will be ignored.

**getEdgeNames**( )
returns list of names for each edge in the polygonal boundary

**getNumEdges**( )
returns total number of edges for the polygonal boundary

**getPoints(** )
returns uniform list of points which define polygonal boundary

**setEdges**( PointList *points*, ulist[string] *edgeNames*)
uses list of points and edge names to set edges and edge names for boundary

**PRBoundary**

PRBoundary class is derived from the base Boundary class, and provides a boundary for a design block, used for Place-and-Route operations. There can only be a single PRBoundary within the current design object (OpenAccess restriction).

**PRBoundary**(PointList *points*, ulist[string] *edgeNames*)
creates PRBoundary, using specified list of points to define polygonal boundary, and list of edge names to name each of the edges defined by polygonal boundary.

**find**()
returns single PRBoundary object for current design.

**Via**

The base class from which standard and custom vias are derived. This is an abstract base class, which is only used for class derivation, and cannot be directly created.

**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns bounding box for this Via

**getLayer1**( )
returns bottom layer for this Via

**getLayer2**( )

returns top layer for this Via

**getMaster(** )
returns master design for this Via

**getName**( )
always returns None; only provided to override PhysicalComponent **getName**()

**getNet**( )
returns any net which is assigned to this Via

**getOrientation**( )
returns orientation for this Via

**getOrigin(** )
returns origin point for this Via

**getTransform**( )
returns any transform defined for this Via

**getViaDefName**( )
returns name of via definition from technology file for this Via

**setName**(string *name*)
*name* is empty string; only provided to override PhysicalComponent **setName**()

**setNet**(Net *net*)
assigns specified *net* to this Via; if *net* is None, then Via is removed from net

**setOrientation**(Orientation *orient*)
sets orientation for this Via

**setOrigin**(Point *origin*)
sets origin point for this Via

**setTransform**(Transform *trans*)
sets transform to be applied to this Via

**StdVia**

The standard via class, which is derived from base Via class. This standard via has a fixed number of pre-defined parameters which can be changed to modify the default standard via. Standard via definition should be specified in associated technology file.

**StdVia**(string *viaDefName*, ViaParam *params* = None,
string *node*= “”, Transform *trans*=None)
creates a standard via object, where *viaDefName* specifies name of standard via definition contained in the associated OpenAccess technology file, and *params* is a ViaParam object which contains all parameter values to be set for this standard via.
**getCutLayer**()
returns cut layer for this standard via
**getImplantLayer1**( )
returns implant layer for bottom layer (layer1) for this standard via
**getImplantLayer2**( )
returns implant layer for top layer (layer2) for this standard via
**getParams**( )
returns ViaParam object which was used to set via parameters for this standard via
**setParams**(ViaParam *params* )
sets via parameters for this standard via, using values contained in *params*

**CustomVia**

The custom via class, which is derived from base Via class. This custom via has set of arbitrary parameters which can be changed to modify the custom via which is generated.

**CustomVia**(string *viaDefName*, ParamArray *params* = None,
string *node*= “”, Transform *trans*=None)
creates a custom via object, where *viaDefName* specifies name of custom via definition contained in the associated OpenAccess technology file, and *params* is a ParamArray object containing all parameter values to be set for this custom via.
**getParams**(ParamArray *params*=None, Bool *all*=True)
returns ParamArray object which was used to set via parameters for this custom via
**setParams**(ParamArray *params* )
sets via parameters for this custom via, using values contained in *params*

**Shape**

The base class from which all shape objects are derived. This is an abstract base class, which is only used for class derivation, and cannot be directly created.

**getBBox**()
returns bounding box for this Shape, using any specified layers
**getColorMask**()
returns coloring information for this Shape for double and triple patterning
**getLayer**()
returns the current Layer for this Shape
**getName**()
returns any optional name which has been assigned to this Shape
**getNet**()
returns any net to which this Shape has been assigned
**getPin**()
returns any pin to which this Shape has been assigned
**setColorMask**(string *anchor*, string *color*)
sets coloring information for this Shape for double and triple patterning
**setLayer**(Layer *layer*)
sets the current Layer for this Shape
**setName**(string *name*)
sets the optional name for this Shape
**setNet**(Net *net*)
sets the net for this Shape, so that this Shape is assigned to a net in the design; if *net* parameter is None, then this Shape is removed from any assigned net.

**Attributes:**
**bbox** – returns the bounding box for this Shape
**layer** – returns the Layer associated with this Shape (settable attribute)
**name** – returns any optional name for this Shape (settable attribute)

**Shape Classes**

These basic shape classes are all derived from the base Shape class. Shape objects are drawn on a single layer, which is passed as the first parameter to the construction method. These basic shape classes include the Arc, Donut, Dot, Ellipse, Line, PathSeg, Polygon, Rect, SimplePath and Text classes. Note that methods are inherited from the base PhysicalComponent and Shape classes.

**Arc**

**Arc**(Layer *layer*, Box *box*, double *startAngle*, double *endAngle*)
creates Arc object defined by bounding box and start and end angles

**clone**()
returns cloned copy of this Arc object

**getEllipseBBox**()
returns bounding box for ellipse which defines this arc

**getStartAngle**()
returns start angle for this arc

**getStopAngle**()
returns stop angle for this arc

**setEllipseBBox**(Box *box*)
sets the bounding box for ellipse which defines this arc

**setStartAngle**(double *startAngle*)
sets the start angle for this arc

**setStopAngle**(double *stopAngle*)
sets the stop angle for this arc

**Donut**

**Donut**(Layer *layer*, Point *center*, Coord *radius*, Coord *holeRadius*)
creates Donut object defined by center point, radius and hole radius

**clone**()
returns cloned copy of this Donut object

**getCenter**()
returns center point for this donut

**getHoleBBox**()
returns bounding box for hole defined by center point and hole radius

**getHoleRadius**()
returns the hole radius (inner radius) for this donut

**getRadius**()
returns the radius (outer radius) for this donut

**setCenter**(Point *center*)
sets the center point for this donut

**setHoleRadius**(Coord *holeRadius*)
sets the hole radius (inner radius) for this donut

**setRadius**(Coord *radius*)
sets the radius (outer radius) for this donut

**Dot**

**Dot**(Layer *layer*, Point *origin*, Coord *width*=0, Coord *height*=0)
creates Dot object defined by origin point, along with optional width and height

**clone**()
returns cloned copy of this Dot object

**getHeight**()
returns height of this dot

**getOrigin**()
returns origin point for this dot

**getWidth**()
returns width of this dot

**setHeight**(Coord *height*)
sets height of this dot

**setOrigin**(Point *origin*)
sets origin point for this dot

**setWidth**(Coord *width*)
sets width of this dot

**Ellipse**

**Ellipse**(Layer *layer*, Box *box*)
creates Ellipse object defined by its bounding box

**clone**()
returns cloned copy of this Ellipse object

**genPolygonPoints**()
generates list of points to approximate ellipse by a polygon

**setBBox**(Box *box*)
sets the bounding box for this ellipse

**Line**

**Line**(Layer *layer*, PointList *points*)
creates Line object defined by list of points, which should not contain any coincident (duplicate) or collinear points

**clone**()
returns cloned copy of this Line object

**getNumPoints**()
returns the number of points contained in this line

**getPoints**()
returns the list of points which defines this line

**setPoints**(PointList *points*)
sets the list of points which defines this line

**Attribute:**

**points** – returns or sets the list of points which defines this line

**Path**

**Path**(Layer *layer*, Coord *width*, PointList *points*,
PathStyle *style*=PathStyle.TRUNCATE)
creates Path object defined by list of points, which should not contain any coincident (duplicate) or collinear points (use PointList **compress**() method)

**clone**()
returns cloned copy of this Path object

**getBeginExt**()
gets begin extension value for this path; only valid for VARIABLE path styles

**getBoundary**(Bool *usePathOrder*=False)
returns list of points which defines the boundary for this path

**getEndExt**()
returns end extension value for this path; only valid for VARIABLE path styles

**getNumPoints**()
returns the number of points which defines this path

**getPoints**()
returns the list of points which defines this path

**getStyle**()
returns path style, as TRUNCATE, EXTEND, ROUND or VARIABLE

**getWidth**()
returns the width for this path

**isOrthogonal**()
returns True if all points in this path are orthogonal, otherwise False

**setBeginExt**(Coord *beginExt*)
sets begin extension value for this path; only valid for VARIABLE path styles

**setEndExt(**Coord *endExt*)
sets end extension value for this path; only valid for VARIABLE path styles

**setPoints**(PointList *points*)
sets the list of points which defines this path

**setStyle**(string *style*)
sets the path style, as TRUNCATE, EXTEND, ROUND or VARIABLE

**setWidth**(Coord *width*)
sets the width for this path

**PathSeg**

**PathSeg**(Layer *layer*, Point *begin*, Point *end*)
creates PathSeg path segment object, defined by begin and end points; these two points must define horizontal, vertical or diagonal segment, or exception is raised.

**clone**()
returns cloned copy of this PathSeg object

**getBoundary**()
returns list of points which define the boundary for this path segment

**getPoints**()
returns the begin point and end point for this path segment

**getWidth**()
returns the width for this path segment
**isOrthogonal**()
returns True if the points for this path segment are orthogonal, otherwise False
**setPoints**(Point *beginPoint*, Point *endPoint*)
sets the begin point and end point for this path segment
**setWidth**(Coord *width*)
sets the width for this path segment

**Polygon**

**Polygon**(Layer *layer*, PointList *points*, Bool *compress*=False)
creates Polygon object defined by list of points, which should not contain any coincident (duplicate) or collinear points (*compress* option removes such points)
**clone**()
returns cloned copy of this Polygon object
**getNumPoints**()
returns number of points which define this polygon
**getPoints**()
returns the list of points which defines this polygon
**isOrthogonal**()
returns True if all vertex points in this polygon are orthogonal, otherwise False
**setPoints**(PointList *points*)
sets the list of points which defines this polygon
**subdivide**(unsigned *numPoints*)
subdivides this polygon into sub-polygons, having fewer than *numPoints* points

**Attribute:**
**points** – returns the list of points which defines this polygon

**Rect**

**Rect**(Layer *layer*, Box *box*)
creates Rect rectangle object defined by bounding box
**clone**()
returns cloned copy of this Rect object
**expand**(Coord *coord*)
expands this rectangle by coordinate value in each direction
**expandDir**(Direction *dir*, Coord *coord*)
expands this rectangle by *coord* coordinate value in specified *dir* direction
**expandToGrid**(Grid *grid*, Direction *dir*=None)
expands this rectangle in direction *dir* to align with nearest grid point
**fillBBoxWithRects**(Layer *layer*, Box *box*, Coord *width*=None, Coord *height*=None,
Coord *spaceX*=None, Coord *spaceY*=None,
GapStyle *gapStyle*=GapStyle.MINIMUM,
Grouping *group*=None)
fills specified *box* with equally sized rectangles on *layer*

**fillDiagBoxWithRects**(Layer *layer*, Box *diagBox*, Coord *width*=None,
Coord *height*=None, Coord *space45*=None,
Coord *space135*=None,
GapStyle *gapStyle*=GapStyle.MINIMUM,
Grouping *group*=None)
fills specified diagonal *box* with equally sized rectangles on *layer*

**fillDiagBoxWithDiagRects**(Layer *layer*, Box *diagBox*, Coord *width45*,
Coord *height135*, Coord *space45*, Coord *space135*,
GapStyle *gapStyle*=GapStyle.MINIMUM,
Grouping *group*=None)
fills specified diagonal *box* with equally sized diagonal rectangles on *layer*

**getBottom**()
returns coordinate value for bottom of this rectangle

**getCoord**(Direction *dir*)
returns coordinate of this rectangle in the *dir* direction

**getHeight**()
returns height of this rectangle

**getLeft**()
returns coordinate value for left side of this rectangle

**getRight**()
returns coordinate value for right side of this rectangle

**getTop**()
returns coordinate value for top of this rectangle

**getWidth**()
returns width of this rectangle

**setBBox**(Box *box*)
sets the bounding box which defines this rectangle

**setBottom**(Coord *v*)
sets coordinate value for bottom of this rectangle

**setCoord**(Direction *dir*, Coord *coord*)
sets this rectangle to have coordinate value in the *dir* direction.

**setLeft**(Coord *v*)
sets coordinate value for left side of this rectangle

**setRight**(Coord *v*)
sets coordinate value for right side of this rectangle

**setTop**(Coord *v*)
sets coordinate value for top of this rectangle

**Attributes:**

**bbox** – returns the bounding box which defines this rectangle
**bottom** – returns coordinate value for bottom of rectangle (settable attribute)
**left** – returns coordinate value for left side of rectangle (settable attribute)
**right** – returns coordinate value for right side of rectangle (settable attribute)
**top** – returns coordinate value for top of rectangle (settable attribute)

**Text**

**Text**(Layer *layer*, string *text*, Point *origin*, Coord *height*)
creates Text object defined by text string, placed at origin point, using *height*

**clone**()
returns cloned copy of this Text object

**getAlignment**()
returns the horizontal and vertical alignment location for this Text object

**getFont**()
returns the font for this Text object

**getHeight**()
returns the height for this Text object

**getOrientation**()
returns the orientation for this Text object

**getOrigin**()
returns the origin point for this Text object

**getText**()
returns the text string for this Text object

**hasOverbar**()
returns True if an overbar is displayed, otherwise False

**isDrafting**()
returns True if drafting mode is enabled, otherwise False

**isVisible**()
returns True if this Text object is visible, otherwise False

**setAlignment**(Location *location*)
sets the horizontal and vertical alignment location for this Text object

**setDrafting**(Bool *drafting*)
sets Boolean flag to control drafting mode for this Text object

**setFont**(Font *font*)
sets the font for this Text object

**setHeight**(Coord *height*)
sets the height for this Text object

**setOrientation**(Orientation *orient*)
sets the orientation for this Text object

**setOrigin**(Point *origin*)
sets the origin point for this Text object

**setOverbar**(Bool *overbar*)
sets Boolean flag to control display of an overbar for this Text object

**setText**(string *text*)
sets the text string for this Text object

**setVisible**(Bool *visible*)
sets Boolean flag to control visibility of this Text object

**TextDisplay**

The abstract base class from which attribute display objects are derived. Note that this class is not directly constructed; all class methods will be inherited by AttrDisplay class.

**getAlignment**()
returns the horizontal and vertical alignment location for this TextDisplay object
**getFont**()
returns the font for this TextDisplay object
**getFormat**()
returns the text display format for this TextDisplay object
**getHeight**()
returns the height for this TextDisplay object
**getOrientation**()
returns the orientation for this TextDisplay object
**getOrigin**()
returns the origin point for this TextDisplay object
**getText**()
returns the text string for this TextDisplay object
**hasOverbar**()
returns True if an overbar is displayed, otherwise False
**isDrafting**()
returns True if drafting mode is enabled, otherwise False
**isVisible**()
returns True if this Text object is visible, otherwise False
**setAlignment**(Location *location*)
sets the horizontal and vertical alignment location for this TextDisplay object
**setDrafting**(Bool *drafting*)
sets Boolean flag to control drafting mode for this TextDisplay object
**setFont**(Font *font*)
sets the font for this TextDisplay object
**setFormat**(TextDisplay.Format *format*)
sets the text display format for this TextDisplay object
**setHeight**(Coord *height*)
sets the height for this TextDisplay object
**setOrientation**(Orientation *orient*)
sets the orientation for this TextDisplay object
**setOrigin**(Point *origin*)
sets the origin point for this TextDisplay object
**setOverbar**(Bool *overbar*)
sets Boolean flag to control display of an overbar for this TextDisplay object
**setVisible**(Bool *visible*)
sets Boolean flag to control visibility of this TextDisplay object

**AttrDisplay**

The derived class from which attribute display objects are created; note that this class is always derived from the TextDisplay abstract base class.

**AttrDisplay**(*obj*, *attribute*, Layer *layer*, Point *origin*, Coord *height*,
Location *location*=Location.UPPER_LEFT,
Orientation *orient*=Orientation.R0,
Font *font*=Font.STICK,
TextDisplay.Format *format*=TextDisplay.Format.NAME_VALUE,
Bool *overbar*=False, Bool *visible*=True, Bool *drafting*=False)

creates attribute display for specified *obj* design object , with specified *attribute* attribute type. The *obj* object is design object corresponding to one of DloGen, Instance, InstTerm, Net or Term classes. The specified *attribute* uses one of pre-defined enumerated classes DloGen.AttrType, Instance.AttrType, InstTerm.AttrType, Net.AttrType or Term.AttrType. Note that attribute type should correspond to design object type.

**getAttribute**()

returns display attribute type for this attribute display

**getObject**()

returns design object for this attribute display

Symbolic constant values used by attribute displays are defined as follows:

| Class Name | Attributes |
|---|---|
| TextDisplay.Format | NAME, NAME_VALUE, VALUE |
| DloGen.AttrType | CELL_NAME, CELL_TYPE, LAST_SAVED_TIME, LIB_NAME, VIEW_NAME |
| Instance.AttrType | CELL_NAME, IS_BOUND, LIB_NAME, NAME, NUM_BITS, VIEW_NAME |
| InstTerm.AttrType | NAME |
| Net.AttrType | IS_EMPTY, IS_GLOBAL, IS_IMPLICIT, NAME, NUM_BITS, SIG_TYPE |
| Term.AttrType | HAS_PINS, NAME, NUM_BITS |

These symbolic constant values are specified using the class name and attribute as follows: TextDisplay.Format.NAME or Term.AttrType.HAS_PINS.

**Reference Classes**

These basic reference classes are all derived from the base PhysicalComponent class. Reference objects are used to refer to a physical component contained in a lower-level of the design hierarchy in a hierarchical layout design. The designer can use these reference objects to directly perform geometric operations; for example, a physical component can be aligned with a poly gate rectangle which is contained within an instance of a transistor. All reference classes are derived from the base PhysicalCompRef reference class.

**PhysicalCompRef**

The base class from which all reference objects are derived. Note that all reference objects are created and managed by the DloGen design class; the DloGen class method **findCompRef**() is used to create and access these reference objects.

**abut**(Direction *dir*, IPhysicalComponent *refComp*, ShapeFilter *filter* = ShapeFilter(), Bool *align*=True, ShapeFilter *refFilter*=None)
abuts component referred to by this reference component

**alignEdge**(Direction *dir*, IPhysicalComponent *refComp*, Direction *refDir*=None, ShapeFilter *filter*=ShapeFilter(), ShapeFilter *refFilter*=None, Coord *offset*=None)
aligns edge of component referred to by this reference component

**alignEdgeToCoord**(Direction *dir*, Coord *coord*, ShapeFilter *filter*=ShapeFilter())
aligns edge of component referred to by this reference component to *coord*

**alignEdgeToPoint**(Direction *dir*, Point *point*, ShapeFilter *filter*=ShapeFilter())
aligns edge of component referred to by this reference component to *point*

**alignLocation**(Location *loc*, IPhysicalComponent *refComp*, Location *refLoc*=None, ShapeFilter *filter*=ShapeFilter(), ShapeFilter *refFilter*=None, Point *offset*=None)
aligns location of component referred to by this reference component

**alignLocationToPoint**(Location *loc*, Point *point*, ShapeFilter *filter*=ShapeFilter())
aligns location of component referred to by this reference component to point

**getBBox**()
returns bounding box for this reference component, relative to current design

**getName()**
returns leaf-level name for this reference component

**getParentPathName()**
returns full hierarchical path name to parent instance containing this reference component within the current DloGen design.

**getParentPathTransform()**
returns transform of the parent Instance, identified by parent path name

**getPathName()**
returns full hierarchical path name for this reference component

**getProps()**
returns properties associated with referenced physical component

**getSpacing**(Direction *dir*, IPhysicalComponent *refComp*,
ShapeFilter *filter*=ShapeFilter(), ShapeFilter *refFilter* = None)
returns spacing distance between this reference component and *refComp* physical component in the specified *dir* direction.

**getTopInst()**
returns top-level instance in design containing this reference component

**mirrorX**(Coord *yCoord*=0)
mirrors this reference component about the X axis

**mirrorY**(Coord *xCoord*=0)
mirrors this reference component about the Y axis

**moveBy**(Coord *dx*, Coord *dy*)
moves this reference component in the x-direction and y-direction

**moveTo**(Coord *x*, Coord *y*, Location *handle*=Location.CENTER_CENTER,
ShapeFilter *filter*=ShapeFilter())
moves this reference component, so bounding box handle aligns with *x* and *y* values

**moveTowards**(Direction *dir*, Coord *d*)
moves this reference component *d* units in the *dir* direction

**overlaps**(Box *box*)
returns True if this reference component overlaps *box*, and returns False otherwise

**place**(Direction *dir*, IPhysicalComponent *refComp*, Coord *distance*,
ShapeFilter *filter*=ShapeFilter(), Bool *align*=True, ShapeFilter *refFilter*=None)
places this reference component *distance* units from the *refComp* component

**rotate90**(Point *origin*=None)
rotates this reference component by 90 degrees

**rotate180**(Point *origin*=None)
rotates this reference component by 180 degrees

**rotate270**(Point *origin*=None)
rotates this reference component by 270 degrees

**snap**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps this reference component, so lower-left bounding box vertex lies on grid

**snapTowards**(Grid *grid*, Direction *dir*, ShapeFilter *filter*=ShapeFilter())
snaps this reference component in the *dir* direction.

**snapX**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps this reference component, so that X coordinate lies on grid

**snapY**(Grid *grid*, SnapType *snapType*=None, ShapeFilter *filter*=ShapeFilter())
snaps this reference component, so that Y coordinate lies on grid

**transform**(Transform *trans*)
applies transform *trans* to this reference component

**Attributes:**

**bbox** – returns bounding box for this physical component reference object

**props** – returns properties associated with referenced physical component

**GroupingRef**

The GroupingRef class is derived from the PhysicalCompRef class, and allows a Grouping object to be used as a reference component. Note that this Grouping should be persistent; this is done with the **makePersistent**() method for the Grouping class.

**getCompRefs**()
returns list of reference physical components within this GroupingRef object

**InstanceRef**

The InstanceRef class is derived from the PhysicalCompRef class, and allows an Instance object to be used as a reference component.

**getCompRefs**()
returns list of reference physical components within this InstanceRef object

**InstanceArrayRef**

The InstanceArrayRef class is derived from the PhysicalCompRef class, and allows an InstanceArray object to be used as a reference component.

**getMemberRefs**()
returns list of reference physical components which are members of this InstanceArray object

**ShapeRef**

The ShapeRef class is provided to allow the designer to easily access read-only shape information, such as is associated with connectivity. This includes information about shapes in the instance master or submaster. Note that there is not any direct OpenAccess equivalent object for this ShapeRef class object.

**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns bounding box, using all layers specified by the *filter* ShapeFilter parameter; converts result from instance submaster coordinates to current design coordinates.

**getLayer**()
returns layer on which the referenced shape has been drawn

**getName**()
returns the optional name for the referenced shape

**getInst**()
returns associated instance for this ShapeRef object

**getInstPin**()
returns associated instance pin for this ShapeRef object

**getTransform**()
returns Transform for associated instance of this ShapeRef object

**Attributes:**

**bbox** –bounding box for this ShapeRef object
**layer** –layer for this ShapeRef object
**name** –name for this ShapeRef object

**ArcRef**

The ArcRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is an arc shape.

**DonutRef**

The DonutRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a donut shape.

**DotRef**

The DotRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a dot shape.

**EllipseRef**

The EllipseRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is an ellipse shape.

**LineRef**

The LineRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a line shape.

**PathRef**

The PathRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a path shape.

**getBeginExt**()
returns beginning extension value for the referenced path
**getBoundary**(Bool *usePathOrder*=False)
returns list of the points which define the referenced path
**getEndExt**()
returns ending extension value for the referenced path
**getNumPoints**()
returns the number of points for the referenced path
**getPoints**()
returns the list of points that define the referenced path
**getStyle**()
returns the end point style for the referenced path
**getWidth**()
returns width of the referenced path
**isOrthogonal**()
returns True, if all points in the referenced path are orthogonal; False otherwise.

**PathSegRef**

The PathSegRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a path segment shape.

**getBoundary**()
returns list of points which define the boundary for the referenced path segment
**getPoints**()
returns begin point and end point for the referenced path segment
**getWidth**()
returns width of the referenced path segment
**isOrthogonal**()
returns True, if points in referenced path segment are orthogonal; False, otherwise.

**PolygonRef**

The PolygonRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a polygon shape. Additional methods are provided to obtain information about the referenced polygon shape.

**getNumPoints**()
returns number of points that define the referenced polygon
**getPoints**()
returns list of points that define the referenced polygon
**isOrthogonal**()
returns True, if all points in referenced polygon are orthogonal; False otherwise.

**RectRef**

The RectRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a rectangle shape.

**TextRef**

The TextRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a text shape.

**TextDisplayRef**

The TextDisplayRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is a text display shape.

**AttrDisplayRef**

The AttrDisplayRef class is derived from the base ShapeRef class, and would be used whenever the referenced shape is an attribute display shape.

# III. BASIC GEOMETRIC CLASSES

The basic geometric classes are used to represent basic geometric objects through use of the Point and Box classes. In addition, the Direction, Location, Orientation and Transform classes are provided to work with these basic geometric objects.

**Point**

Basic geometric point class, used to represent a single point in the x-y coordinate space used to define layout objects. A point is defined by its x and y coordinate values. The Python addition and subtraction operators have been overloaded to work with points.

**Point**(Coord *x*=0, Coord *y*=0)
creates Point object, using the specified x and y coordinate values
**areColinearPoints**(Point *p1*, Point *p2*, Point *p3*)
returns True if 3 points are collinear or coincident, and returns False otherwise
**copy**()
returns a copy of this Point object
**getCoord**(Direction *dir*)
returns the coordinate value in the specified direction *dir* for this point
**getSpacing**(Direction *dir*, Point *refPoint*)
returns relative spacing distance from this point to *refPoint* reference point
**getX**()
returns x-coordinate value for this Point
**getY**()
returns y-coordinate value for this Point
**invalid**()
returns the pre-defined invalid point value in the x-y coordinate space
**isBetween**(Point *a*, Point *b*)
Returns True if this Point lies between specified points on either horizontal or vertical line segment; returns False otherwise. Typically used for routing purposes.
**isValid**()
returns True if this Point represents valid point in x-y coordinate space
**place**(Direction *dir*, Point *refPoint*, Coord *distance*, Bool *align*=True) –
places this point *distance* units from *refPoint* reference point in given direction *dir*
**set**(Point *p*)
**set**(Coord *_x*, Coord *_y*)
sets the point value (or coordinate value) for this point
**setCoord**(Direction *dir*, Coord *coord*)
sets the *coord* coordinate value in the specified direction *dir* for this point
**setX**(Coord *x*)
sets x-coordinate value for this Point object
**setY**(Coord *y*)
sets y-coordinate value for this Point object
**snap**(Coord *grid*, SnapType *snapType*=None)
snaps this point to nearest grid point, using the *snapType* rounding method

**snapX**(Coord *grid*, SnapType *snapType*=None)
snaps the x-coordinate of this point to nearest grid point, using *snapType* rounding
**snapY**(Coord *grid*, SnapType *snapType*=None)
snaps the y-coordinate of this point to nearest grid point, using *snapType* rounding
**snapTowards**(Coord *grid*, Direction *dir*)
snaps this point to nearest grid point in the specified direction *dir*
**toDiagAxes**()
transforms point specified in orthogonal coordinate axis values to diagonal axes
**toOrthogAxes**()
transforms point specified in diagonal coordinate axis values to orthogonal axes
**transform**(Transform *trans*)
applies the Transform to this Point object (see description of **Transform** class)

**Attributes:**
**x** – returns value of x-coordinate for this point (settable attribute)
**y –** returns value of y-coordinate for this point (settable attribute)

## Range

This is the basic geometric range class which defines a one-dimensional range of values in the x-y coordinate space which is used to define layout objects. This range is defined by the two coordinate values for the range, the left and right values for the range.

**Range**(Coord *left*, Coord *right*)
**Range**(Range *r*)
creates Range object, using the specified left and right coordinate values
**alignEdge**(Direction *dir*, Range *refRange*, Direction *refDir*=None,
Coord *offset*=None)
moves this range to align in the given directions with the *refRange* reference range; if *offset* is specified, then it is added to distance required to align these two ranges.
**alignEdgeToCoord**(Direction *dir*, Coord *coord*)
moves this range to align in the given direction with the *coord* coordinate
**compareTrueCenter**()
compares floating-point user units with database integer units for center point
**contains**(Range *range*, Bool *incEnds*=True)
returns True if this range contains the specified range; if *incEdges* is True, then *range* will be contained, if left and right coordinates are within this range.
**containsCoord**(Coord *coord*, Bool *incEnds*=True)
returns True if this range contains *coord* coordinate; if *incEdges* flag True, then *coord* will be contained, if same value as range left or right coordinate.
**expand**(Coord *coord*)
expands this range by the *coord* coordinate value in both directions
**expandDir**(Direction *dir*, Coord *coord*)
expands this range by the *coord* coordinate value in the *dir* direction
**findAlignEdgeOffset**(int *moveEdgeLean*, int *refEdgeLean*)
adjusts edge alignment between floating-point user units and integer database units

**fitSubranges**(Coord *width*, Coord *space*, Coord *gridSize*, GapStyle *gapStyle*)
returns number of equally sized subranges which can fit within this range
**fix**()
checks for inverted range; if so, swaps left and right coordinates
**getCenter**()
returns midpoint value for this range
**getCoord**(Direction *dir*)
returns left or right coordinate value for this range, using *dir* direction
**getLeft**()
returns left coordinate value for this range
**getRight**()
returns right coordinate value for this range
**getWidth**()
returns width of this range
**hasNoWidth**()
returns True if this range has zero width, and returns False otherwise
**init**()
sets this range to an inverted range with maximum values
**intersect**(Range *range*, Direction *dir*=None)
returns intersection of this range and the passed parameter *range*, using *dir* direction to determine which coordinate values should be changed.
**isInverted**()
returns True if right coordinate is less than left coordinate, and False otherwise
**isNormal**()
returns True if left coordinate is less than right coordinate, and False otherwise
**limit**(Coord *coord*)
returns coordinate found by limiting *coord* to be within this range
**merge**(Range *range*, Direction *dir*=None)
merge this range with the passed *range* parameter range, using *dir* direction to determine which coordinate values should be changed.
**mergeCoord**(Coord *coord*)
this range is merged with the passed *coord* parameter
**moveBy**(Coord *coord*)
moves this range by the specified *coord* offset coordinate value
**overlaps**(Range *range*, Bool *incEnds*=True)
returns True if range has any overlap with *range*; if *incEdges* is True, then ranges overlap, if the left or right coordinate values are within this range.
**removeRegion**(Range *range*)
removes sub- region of this range specified by the *range* parameter
**set**(Range *r*, Direction *dir*=None)
**set**(Coord *left*, Coord *right*)
sets both the left and right coordinate values for this range, using *dir* direction to determine which coordinate values should be changed.
**setCenter**(Coord *coord*)
sets midpoint value for this range

**setCoord**(Direction *dir*, Coord *coord*)
sets the left or right coordinate values, using specified *dir* direction
**setDimension**(Coord *coord*, Direction *dir*=None)
sets width for this range, using *dir* direction to determine which coordinate values should be changed.
**setLeft**(Coord *v*)
sets the left coordinate value for this range
**setRight**(Coord *v*)
sets the right coordinate value for this range
**setWidth**(Coord *width*)
sets width for this range, so that midpoint of range will be the same

**Attributes:**

**left** – returns value for left coordinate of this range (settable attribute)
**right** – returns value for right coordinate of this range (settable attribute)

**Segment**

Basic geometric segment class, used to define a line segment in the x-y coordinate space used to define layout objects. This segment is defined by two end point values, the head point and the tail point.

**Segment**(Point *head*, Point *tail*)
**Segment**(Segment *s*)
creates Segment object, using the specified *head* and *tail* Point or *s* Segment values
**addOffsets**(Coord *begin*=0, Coord *end*=0)
adds *begin* offset value to the head point and *end* offset value to the tail point
**contains**(Segment *segment*, Bool *incEnds*=True)
returns True if specified Segment is included in this Segment, and returns False otherwise. If *incEnds* is True, then end points of this Segment will be used.
**containsPoint**(Point *point*, Bool *incEnds*=True)
returns True if specified Point is included in this Segment, and returns False otherwise. If *incEnds* is True, then end points of this Segment will be used.
**extrapIntersect**(Segment *segment*)
returns intersection of this Segment and specified Segment, after extrapolating each of these segments into complete lines.
**genJustifySegment**(Direction *justify*, Coord *sep*)
returns justified segment constructed from this Segment
**getDeltaX**()
returns difference in x-coordinate values between tail and head end points
**getDeltaY**()
returns difference in y-coordinate values between tail and head end points
**getDir**()
returns Direction associated with this Segment, by moving from head to tail
**getHead**()
returns the head end point value for this segment

**getPosition**(double *position*)
returns Point on this Segment determined by value of *position* parameter
**getTail**()
returns the tail end point value for this segment
**hasIntersection**(Segment *segment*, Bool *incEnds*=True, Bool *incParallel*=True)
returns True if Segment has intersection with *segment*, and returns False otherwise
**intersect**(Segment *segment*)
returns intersection of this Segment with *segment*
**isCoincident**()
returns True if head and tail points are coincident, and returns False otherwise
**isHorizontal** ()
returns True if this Segment is horizontal, and returns False otherwise
**isOrthogonal**()
returns True if this Segment is orthogonal, and returns False otherwise
**isParallel**(Segment *segment*)
returns True if this Segment is parallel to *segment*, and returns False otherwise
**isVertical** ()
returns True if this Segment is vertical, and returns False otherwise
**moveBy**(Coord *dx*, Coord *dy*)
moves this Segment by the specified *dx* and *dy* offset coordinate values
**reverse** ()
reverses this Segment, by interchanging head and tail end point values
**set**(Point *head*, Point *tail*)
sets the head and tail end point values for this Segment
**setHead**(Point *headl*)
sets the head end point value for this Segment
**setTail**(Point *tail*)
sets the tail end point value for this Segment
**transform**(Transform *trans*)
applies *trans* transform to the head and tail points of this Segment

**Attributes:**

**head** – returns value for head end point of this segment (settable attribute)
**tail** – returns value for tail end point of this segment (settable attribute)

**Box**

Basic geometric box class, used to specify bounding box which is used to define basic shapes for layout design objects.

**Box**(Coord *left*=INT_MAX, Coord *bottom*=INT_MAX,
Coord *right*=INT_MIN, Coord *top*=INT_MIN)
**Box**(Point *lowerLeft*, Point *upperRight*)
**Box**(Box *b*)
creates Box object using parameter values to define the dimensions of the box

**abut**(Direction *dir*, Box *refBox*, Bool *align*=True)
abuts edge of box to opposite edge of *refBox*, using edge specified by *dir* direction
**alignEdge**(Direction *dir*, Box *refBox*, Direction *refDir*=None, Point *offset*=None)
aligns an edge of this box with an edge of the specified *refBox* reference box
**alignEdgeToCoord**(Direction *dir*, Coord *coord*)
aligns an edge of this box to the specified coordinate, in the specified *dir* direction
**alignEdgeToPoint**(Direction *dir*, Point *point*)
aligns an edge of this box to the specified point, in the specified *dir* direction
**alignLocation**(Location *loc*, Box *refBox*, Location *refLoc*=None, Point *offset*=None)
aligns *loc* location point for this box with the *refLoc* location point for the *refBox*
**alignLocationToPoint**(Location *loc*, Point *pt*)
aligns *loc* location point for this box with the specified point
**centerCenter**()
returns center center point for this box
**centerLeft**()
returns center left point for this box
**centerRight**()
returns center right point for this box
**contains**(Box *box*, Bool *incEdges*=True)
returns True if this box contains the specified box; if *incEdges* is True,
then *box* will be considered contained if it touches edges of this box.
**containsPoint**(Point *pt*, Bool *incEdges*=True)
returns True if this box contains the specified point; if *incEdges* is True,
then point will be considered contained if it touches edges of this box.
**expand**(Coord *c*)
expands box by coordinate value in each direction
**expandDir**(Direction *dir*, Coord *coord*)
expands box by coordinate value in specified direction
**expandForMinArea**(Direction *dir*, AreaType *minArea*, Grid *grid*=None)
expands box in direction *dir*, so that the area is at least *minArea*;
used to check that Box meets minimum area design rules.
**expandForMinWidth**(Direction *dir*, Coord *minWidth*, Grid *grid*=None)
expands box in direction *dir*, so that height or width is at least *minWidth*;
used to check that Box meets minimum width design rules.
**expandToGrid**(Grid *grid*, Direction *dir*=None)
expands box in direction *dir* to align with nearest grid point
**fix**()
checks to see if box is inverted; if so, swaps coordinates and returns resulting box
**getArea**()
returns area of this box, which can be negative for an inverted box
**getBottom**()
returns coordinate value for bottom of this box
**getCenter**()
returns coordinates for center point of this box
**getCenterX**()
returns x-coordinate value for center point of this box

**getCenterY**()
returns y-coordinate value for center point of this box
**getCoord**(Direction *dir*)
returns coordinate of this box in the specified direction
**getDimension**(Direction *dir*)
returns dimensions of this box in the specified direction
**getHeight**()
returns height of this box
**getLeft**()
returns coordinate value for left side of this box
**getLocationPoint**(Direction *dir*)
returns location point for this box, at given direction
**getLocationPoint**(Location *loc*)
returns location point for this box, at given location
**getPoints**()
returns list of four points which are defined by corners of this box
**getRange**(Direction *dir*)
returns coordinate values for this box in the specified direction, as a range value
**getRangeX**()
returns left and right coordinate values for this box as a range value
**getRangeY**()
returns bottom and top coordinate values for this box as a range value
**getRight**()
returns coordinate value for right side of this box
**getSpacing**(Direction *dir*, Box *refBox*)
returns spacing value between this box and reference box in the *dir* direction
**getTop**()
returns coordinate value for top of this box
**getWidth**()
returns width of this box
**hasNoArea**()
returns True if this box has no area
**init**()
returns an inverted box with maximum values used for top, bottom, left and right
**intersect**(Box *box*)
returns intersection of this box with the specified box
**intersect**(Box *box*, Direction *dir*)
returns intersection of this box with the specified box in the specified direction
**isInverted**()
returns True, if this box is inverted
**isNormal**()
returns True if this box is not inverted, and returns False otherwise
**limit**(Point *point*)
returns point which is found by limiting *point* to be within this box
**lowerCenter**()
returns lower center point for this box

**lowerLeft**()
returns lower left point for this box
**lowerRight**()
returns lower right point for this box
**merge**(Box *box*)
merges this box with specified box, returning resulting merged box
**merge**(Box *box*, Direction *dir*)
merges this box with specified box in specified direction, returning merged box
**mergePoint**(Point *p*)
merges this box with the specified point, and returns the resulting merged box
**mirrorX**(Coord *yCoord*=0)
mirrors this box about the X coordinate axis
**mirrorY**(Coord *xCoord*=0)
mirrors this box about the Y coordinate axis
**moveBy**(Coord *dx*, Coord *dy*)
moves this box by the specified *dx* and *dy* offset coordinate values
**moveTo**(Point *destination*, Location *loc*=Location.CENTER_CENTER)
moves this box to specified *destination* point, coinciding with *loc* location
**moveTowards**(Direction *dir*, Coord *d*)
moves this box by *d* coordinate value distance, in specified *dir* direction
**overlaps**(Box *box*, Bool *incEdges*=True)
returns True if this box has any overlap with the specified box; if *incEdges* is True, then boxes will be considered to overlap if the edges touch.
**place**(Direction *dir*, Box *refBox*, Coord *distance*, Bool *align*=True)
places this box relative to the *refBox* reference box in the specified *dir* direction; if *align* is True, then this box will first be aligned with the reference box.
**removeRegion**(Box *box*)
removes the region of this box specified by the *box* sub-box parameter
**rotate90**(Point *origin*=None)
rotates this box by 90 degrees, in a counter-clockwise direction
**rotate180**(Point *origin*=None)
rotates this box by 180 degrees, in a counter-clockwise direction
**rotate270**(Point *origin*=None)
rotates this box by 270 degrees, in a counter-clockwise direction
**set**(Coord *left*, Coord *bottom*, Coord *right*, Coord *top*)
**set**(Point *lowerLeft*, Point *upperRight*)
**set**(Box *b*)
sets this box to have the specified coordinate or box values
**set**(Box *b*, Direction *dir*=None)
sets this box to have the specified box value in specified direction
**setBottom**(Coord *v*)
sets coordinate value for bottom of this box
**setCenter**(Point *point*)
sets center point for the center of this box
**setCenterX**(Coord *v*)
sets x-coordinate value for the center of this box

**setCenterY**(Coord *v*)
sets y-coordinate value for the center of this box
**setCoord**(Direction *dir*, Coord *coord*)
sets this box to have the coordinate value in the specified direction
**setDimension**(Coord *coord*, Direction *dir*)
sets dimensions of this box in the specified direction
**setHeight**(Coord *height*)
sets height of this box
**setLeft**(Coord *v*)
sets coordinate value for left side of this box
**setLocationPoint**(Location *loc*, Point *pt*)
moves this box, so that the *pt* point becomes the location point at the *loc* location
**setRange**(Direction *dir*, Range *range*)
sets this box to have the *range* coordinate values in the given direction
**setRangeX**(Range *range*)
sets left and right coordinate values for this box
**setRangeY**(Range *range*)
sets bottom and top coordinate values for this box
**setRight**(Coord *v*)
sets coordinate value for right side of this box
**setTop**(Coord *v*)
sets coordinate value for top of this box
**setWidth**(Coord *width*)
sets width of this box
**snap**(Grid *grid*, SnapType *snapType*=None)
snaps lower left point of this box to nearest grid point
**snapX**(Grid *grid*, SnapType *snapType*=None)
snaps left coordinate of this box to nearest grid point.
**snapY**(Grid *grid*, SnapType *snapType*=None)
snaps bottom coordinate of this box to nearest grid point.
**snapTowards**(Grid *grid*, Direction *dir*)
snaps lower left point of this box to nearest grid point in the specified direction
**transform**(Transform *trans*)
apply specified transform to this box
**upperCenter**()
returns the upper center point for this box
**upperLeft**()
returns the upper left point for this box
**upperRight**()
returns the upper right point for this box

**Attributes:**

**bottom** – returns coordinate value for the bottom of this box (settable attribute)
**left** – returns coordinate value for the left side of this box (settable attribute)
**right** – returns coordinate value for the right side of this box (settable attribute)
**top** – returns coordinate value for the top of this box (settable attribute)

**Direction**

Defines one of several directions, along with methods to manipulate them. Defines symbolic constants for directions: NONE, NORTH, NORTH_EAST, EAST, SOUTH_EAST, SOUTH, SOUTH_WEST, WEST, NORTH_WEST, NORTH_SOUTH, EAST_WEST, ANY, CENTER.

**containsComponent**(Direction *dir*)
returns True if *dir* direction is a component of this Direction, and False otherwise.
**extend**()
extends this one dimensional Direction to a full-line direction
**getJustifiedDir**(Direction *justify*)
returns half-line direction perpendicular to this primary Direction, justified relative to specified *justify* direction, which should either be EAST or WEST.
**getMembers**()
returns list of all directions defined for the Direction class.
**getPrimaryDirs** ()
returns list of one or more primary directions contained in this Direction.
**is1Dimension**()
returns True if this Direction is a one dimension direction, and False otherwise
**isHalfLine**()
returns True if this Direction is a one dimension direction, and False otherwise
**isFullLine**()
returns True if this Direction is a full-line direction, and False otherwise
**isPrimary**()
returns True if this Direction is a primary direction, and False otherwise
**isXDir**()
returns True if this Direction is defined by the X-axis, and False otherwise
**isYDir**()
returns True if this Direction is defined by the Y-axis, and False otherwise
**mapXDirToYDir**()
maps this Direction defined by the X-axis to a direction defined by the Y-axis
**mapYDirToXDir**()
maps this Direction defined by the Y-axis to a direction defined by the X-axis
**mirrorX**()
returns resulting direction when this Direction is mirrored about the X-axis
**mirrorY**()
returns resulting direction when this Direction is mirrored about the Y-axis
**opposite**()
returns the opposite direction for this Direction object
**perpendicular**()
returns the perpendicular direction for this Direction object
**rotate90**()
returns resulting direction when this Direction is rotated 90 degrees
**rotate180**()
returns resulting direction when this Direction is rotated 180 degrees

**rotate270**()
returns resulting direction when this Direction is rotated 270 degrees
**transform**(Transform *trans*)
returns resulting direction when *trans* transform is applied to this Direction

### Location

Specifies one of nine locations for points on a bounding box. Defines symbolic constants for locations: LOWER_LEFT, CENTER_LEFT, UPPER_LEFT, LOWER_CENTER, CENTER_CENTER, UPPER_CENTER, LOWER_RIGHT, CENTER_RIGHT, UPPER_RIGHT.

**mirrorX**()
returns resulting location when this Location is mirrored about the X-axis
**mirrorY**()
returns resulting location when this Location is mirrored about the Y-axis.
**rotate90**()
returns resulting location when this Location is rotated 90 degrees
**rotate180**()
returns resulting location when this Location is rotated 180 degrees
**rotate270**()
returns resulting location when this Location is rotated 270 degrees
**transform**(Transform *trans*)
returns resulting location when *trans* transform is applied to this Location

### Orientation

Provides ability to rotate an object (counter-clockwise) or mirror it about the X or Y coordinates axes. In addition, a combination of rotation and mirroring can be defined.
**concat**(Orientation *other*)
returns result of applying these two Orientation operations in sequence
**getRelativeOrient**(Orientation *o*)
returns Orientation required to convert this Orientation into the *o* Orientation

### Transform

Provides two-dimensional transformations, consisting of orientation changes (rotation and mirroring) followed by a possible translation (offsets in the X and Y directions).

**Transform**(Coord *x*, Coord *y*, Orientation *o*=R0)
**Transform**(Point *offset*, Orientation *o*=R0)
creates Transform object defined by orientation (rotation) and point (translation)
**concat**(Transform *transform*)
concatenates this Transform with passed *transform*, and returns result
**invert**()
inverts this Transform object and returns result
**mirrorX**(Coord *yCoord*=0)
returns Transform using MX mirroring orientation

**mirrorY**(Coord *xCoord*=0)
returns Transform using MY mirroring orientation
**rotate90**(Point *origin*=None)
returns Transform using R90 rotation orientation
**rotate180**(Point *origin*=None)
returns Transform using R90 rotation orientation
**rotate270**(Point *origin*=None)
returns Transform using R90 rotation orientation
**Attributes:**
**offset** – returns offset point value for this Transform
**xOffset** – returns x-coordinate value of the offset for this Transform
**yOffset** – returns y-coordinate value of the offset for this Transform
**orientation** – returns orientation value for this Transform

## Font

Specifies one of nine different fonts which can be used by a text object. Defines symbolic constants for fonts: EURO_STYLE, FIXED, GOTHIC, MATH, MIL_SPEC, ROMAN, SCRIPT, STICK and SWEDISH.

**calcBBox**(str *text*, Point *origin*,Coord *height*,
Location *location*=Location.UPPER_LEFT,
Orientation *orient*=Orientation.R0, Bool *overbar*=False)
calculates bounding box for this Font object for specified text string
**getMembers**()
returns list of members for Font class

## PathStyle

Specifies one of four path styles which can be used to specify the beginning and ending point styles for a path. Defines symbolic constants for path styles: TRUNCATE, EXTEND, ROUND, VARIABLE.

## GapStyle

Specifies one of three types of spacing which should be used between rectangles in a field of rectangles. Defines symbolic constants for gap style spacing: DISTRIBUTE, MINIMUM, MIN_CENTER.

# IV. TECHNOLOGY CLASSES

The technology classes are used to access technology specific information stored in the Santana technology file. These classes include the Grid, Layer, ShapeFilter and Tech classes.

## Layer

This class is used to store the basic information concerning a layer in an integrated circuit, including the layer name, layer purpose and layer number.

**Layer**(string *name*)
creates Layer object corresponding to named layer in technology file
**getGridResolution**()
returns grid resolution value for this layer (in user units)
**getLayerAbove**()
**getLayerAbove**(LayerMaterial *material*)
returns layer above this layer, based on layer mask numbers
**getLayerBelow**()
**getLayerBelow**(LayerMaterial *material*)
returns layer below this layer, based on layer mask numbers
**getLayerName**()
returns name of this layer
**getLayerNumber**()
returns number of this layer
**getMaterial**()
returns the material for this layer
**getPurposeName**()
returns purpose name defined for this layer
**getPurposeNumber**()
returns purpose number defined for this layer
**isAbove**(Layer *layer*)
returns True if this layer is above the passed layer, based on layer mask numbers
**isMaskLayer**()
returns True if this layer is a mask layer, and False otherwise

**Attributes:**

**name** – returns name for this layer
**number** – returns number defined for this layer
**purposeName**– returns purpose name defined for this layer
**purposeNumber**– returns purpose number defined for this layer

### ShapeFilter

This class is used to define the different layers which should be considered when making bounding box calculations as well as placement calculations. This class consists of a list of layers, along with an optional Boolean flag.

**ShapeFilter**()
**ShapeFilter**(Layer *layer*)
**ShapeFilter**(LayerList *layerList*)
creates ShapeFilter object, which can be empty, a single layer or list of layers
**exclude**(*layers*)
removes layer (or layer list) from list of layers selected by this ShapeFilter
**include**(*layers*)
adds layer (or layer list) to list of layers selected by this ShapeFilter
**isIncluded**(Layer *layer*)
returns True if *layer* parameter specifies layer which is selected by this ShapeFilter

### LayerMaterial

Specifies the layer material to be used for physical layer on a chip. Defines symbolic constants for layer material: NWELL, PWELL, NDIFF, PDIFF, NIMPLANT, PIMPLANT, POLY, CUT, METAL, CONTACTLESS_METAL, DIFF, RECOGNITION or UNKNOWN.

## PhysicalRule

Represents the values of a physical design rule, either as a single floating-point number, pair of floating-point numbers, or list of pairs of floating-point numbers. It is derived from Python float class, so a single number can be used just like a float.

**Attributes:**
**value** – returns value of this physical design rule
**properties** – returns any properties defined for this physical design rule

## RuleProperty

Represents properties associated with a physical design rule in the technology file; Similar to the use of parameter names and values used for conditional design rules.

**Attributes:**
**name** – name of rule property
**value** – value of associated rule property

**DeviceContext**

This class is used to allow the PyCell author to automatically use different design rules when certain devices are constructed. For example, special design rules are typically used when creating high-voltage devices. If a device context is defined in the technology file for high-voltage devices, technology query functions for physical design rules will return values which should be used for creating high-voltage devices. In addition, FG methods such as "fgPlace()" would automatically use these high-voltage device values.

**getLayers**()
returns list of layers defined for this device context in the technology file
**getName**()
returns name assigned to this device context in the technology file
**getRuleSubstitutions**()
returns Python dictionary containing different rule substitutions defined for this device context in the technology file.
**isEmpty**()
returns true if this device context is empty, and returns False otherwise

**Attributes:**
**layers** – list of layers for this device context
**name** – name assigned to this device context
**ruleSubstitutions** – list of rule substitutions for this device context
**emptyContextName** – name of pre-defined empty device context

**Ruleset**

This class allows the PyCell author to access different rule sets defined in the Santana technology file. A design rule set is simply a named set of design rules in the technology file, which can be referenced and activated using the design rule set name in the PyCell code. For example, "recommended" design rule sets can be used in PyCell construction; these design rules can be used to improve manufacturing yield, but are not required to be used to verify basic design rule correctness for a design.

**getAncestor**()
returns ancestor design rule set for this design rule set
**getName**()
returns name assigned to this design rule set

**Attributes:**
**name** – name assigned to this design rule set
**ancestor** – ancestor design rule set for this design rule set
**defaultName** – name used by default design rule set

**Tech**

This class stores all technology specific information contained in the Santana technology file for a given process technology. This technology specific information contains process specific physical design rules, as well as electrical design rules. In addition, conditional physical design rules are supported, where a design rule value depends upon one or more parameters. Note that this Tech class object is automatically created and associated with the DloGen, Lib and ParamSpecArray class objects.

**conditionalRuleExists**(string *ruleName*, list *paramNames*)
**conditionalRuleExists**(string *ruleName*, Layer *layer1*, list *paramNames*)
**conditionalRuleExists**(string *ruleName*, Layer *layer1*, Layer *layer2*, list *paramNames*)
returns True if the named conditional design rule exists in the technology file
**dbu2uu**(int *value*, ViewType *viewType*=MASK_LAYOUT)
returns user unit value corresponding to specified database unit value
**dbu2uuArea**(int *value*, ViewType *viewType*=MASK_LAYOUT)
returns user unit value corresponding to specified square database unit value
**deviceContextExists** (string *name*)
returns True if named device context exists in technology file, and False otherwise
**electricalRuleExists**(string *ruleName*)
**electricalRuleExists**(string *ruleName*, Layer *layer1*)
**electricalRuleExists**(string *ruleName*, Layer *layer1*, Layer *layer2*)
returns True if the named electrical design rule exists in the technology file
**get**(string *techLibName*, *cnTechVersion*=None)
returns technology object corresponding to technology library name
**getActiveDeviceContext**()
returns currently active device context for this Tech object
**getActiveRuleset**()
returns currently active rule set for this Tech object
**getDeviceContexts**()
returns list of all device contexts defined for this Tech object
**getElectricalRule**(string *ruleName*)
**getElectricalRule**(string *ruleName*, Layer *layer1*)
**getElectricalRule**(string *ruleName*, Layer *layer1*, Layer *layer2*)
returns the value for the named electrical design rule stored in the technology file; if this named electrical design rule does not exist, then an exception is raised.
**getGridResolution**()
returns default manufacturing grid resolution value (in user units)
**getIntermediateLayers**(Layer *layer1*, Layer *layer2*)
returns lists of route layers and cut layers defined between these two layers
**getLayer**(string *layerName*)
**getLayer**(unsigned int *layerNumber*)
**getLayer**(string *layerName*, string *purposeName*)
**getLayer**(unsigned int *layerNumber*, unsigned int *purposeNumber*)
returns the requested layer from the Santana technology file

**getMosfetParams**(string *type*, string *oxide*, string *parameter*)
returns value stored in Santana technology file for MOSFET transistor parameter
**getOxideParams**(string *oxide*, string *parameter*)
returns value stored in Santana technology file for oxide parameter
**getPhysicalRule**(string *ruleName*)
**getPhysicalRule**(string *ruleName*, Layer *layer1*)
**getPhysicalRule**(string *ruleName*, Layer *layer1*, Layer *layer2*)
returns the value for the named physical design rule stored in the technology file; if this named physical design rule does not exist, then an exception is raised.
**getRulesets**()
returns uniform list of all rule sets for this Tech object
**getSantanaLayerNames**()
returns list of layer names defined in the Santana technology file
**getSantanaPurposeNames**()
returns list of purpose names defined in the Santana technology file
**getUserUnits**(ViewType *viewType*=MASK_LAYOUT)
returns the user units for the specified view type
**id**()
returns identification string for Santana technology file, which is a combination of the name string, revision and version numbers for the Santana technology file.
**name**()
returns name string for Santana technology file
**physicalRuleExists**(string *ruleName*)
**physicalRuleExists**(string *ruleName*, Layer *layer1*)
**physicalRuleExists**(string *ruleName*, Layer *layer1*, Layer *layer2*)
returns True if the named physical design rule exists in the technology file
**revision**()
returns revision number for Santana technology file
**rulesetExists**(string *name*)
returns True if named rule set exists in technology file, and False otherwise
**uu2dbu**(double *value*, ViewType *viewType*=MASK_LAYOUT)
returns database unit value corresponding to specified user unit value
**uu2dbuArea**(double *value*, ViewType *viewType*=MASK_LAYOUT)
returns database unit value corresponding to specified square user unit value
**version**()
returns version (as an unsigned integer) for Santana technology file

**Attributes:**

**activeDeviceContext** – currently active device context for this Tech object
**deviceContexts** – list of all device contexts for this Tech object
**activeRuleset**– currently active rule set for this Tech object
**rulesets** – list of all rule sets for this Tech object
**techParams** – read-only Python dictionary containing technology parameters and values stored in the corresponding OpenAccess tech database.

# V. CONNECTIVITY CLASSES

The connectivity classes are used to represent basic design connectivity. These classes include the Net, Pin, Term, InstTerm, InstPin and Topology classes.

**SignalType**

Defines one of several signal types which can be associated with a Net object. Defines symbolic constants for these signal types: SIGNAL, POWER, GROUND, CLOCK, TIEOFF, TIEHI, TIELO, ANALOG, SCAN, RESET.

**TermType**

Defines one of several terminal types for a terminal in a design. Defines symbolic constants for these terminal types: INPUT, OUTPUT, INPUT_OUTPUT, SWITCH, JUMPER, UNUSED, TRISTATE.

**Net**

Represents the basic connectivity within a design. These Net objects can be connected to terminals on a design instance.

**Net**(string *netName*, SignalType *sigType*=SignalType.SIGNAL, Bool *isGlobal*=False)
creates net in the current design, using *sigType* to specify signal type for this net; *isGlobal* Boolean flag parameter is set to True, for a global net in the design.

**addShape**(Shape *shapes*)
**addShape**(ulist[Shapes] *shapes*)
adds the shape(s) to this net; if this shape is associated with another net, then an exception will be raised, since a shape can only be associated with a single net.

**destroy**()
destroys this net object, by first destroying any terminals for this net

**find**(*name=''*)
returns the net having this name in the current DloGen design

**findCreate**()
returns the net having this name in the current DloGen design; if there is not any net in the current design having this name, then a new net will be created.

**getName**()
returns the name for this net

**getShapes**()
returns list of shapes which are currently associated with this net

**getSignalType**()
returns the signal type value assigned to this net

**getInstPins**()
returns a list of InstPin objects associated with this net

**getInstTerms**()
returns a list of InstTerm objects associated with this net

**getPins**()
returns a list of pins which are connected to any terminal associated with this net

**getTerm**()
returns any terminal that is associated with this net
**getVias**()
returns list of all vias which are associated with this net
**isGlobal**()
returns a Boolean flag value indicating that this net is a global net
**removeShape**(Shape *shapes*)
**removeShape**(ulist[Shapes] *shapes*)
removes the shape(s) from this net
**setGlobal**()
sets the Boolean flag indicating that this net is a global net
**setName**(string *name*)
sets the name for this Net object; the name of any associated terminal for this net will also be changed, ensuring that terminals and nets will have the same name.
**setNetOverride** (string *assignmentName*, string *netName*)
creates an oaNetConnectDef associating this single-bit net with the oaAssignment named *assignmentName*. If the oaAssignment referred to does not exist, this single-bit net is associated with the net named *netName*. An exception is thrown if the net named *netName* does not exist.
**setSignalType**()
sets the signal type value for this net

**Attributes:**

**name** – the name of this net (settable attribute)
**type** – the signal type for this net (settable attribute)
**globalNet** – value of the Boolean flag for global nets (settable attribute)
**AttrType** – display attribute type for this net

**Pin**

Represents the physical connection of terminals on a design instance to nets in the design. Note that a terminal can have more than one pin, so that multiple Pin objects can represent multiple physical connections, which are viewed as a single logical connection.

**Pin**(string *pinName*, string *termName*, Shape *shape*=None)
creates a Pin object for the specified terminal in the current design;
*shape* parameter can be used to optionally associate a shape with this pin.
**addInstPin**(InstPin *instPin*, ShapeFilter *filter*=ShapeFilter())
uses shape references from *instPin* to create shapes associated with this pin
**addShape**(Shape *shapes*)
**addShape**(ulist[Shapes] *shapes*)
adds shape(s) to this pin; a shape can only be associated with a single pin
**destroy**()
destroys this pin, as well as the underlying OpenAccess database object

**find**(*name*='')
returns the pin having this name in the current DloGen design
**getAccessDir**()
returns access direction(s) for this pin (viewed from Instance containing this pin)
**getAuthorPrefLayer**()
returns layer which is the author-specified preferred layer for routing purposes
**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns merged bounding box of geometries on layers specified by the *filter* ShapeFilter for which this pin has associated geometries
**getLayers**()
returns list of layers on which this pin has associated geometries
**getName**()
returns the name for this pin
**getNet**()
returns the net which is associated with this pin
**getPrefLayer**()
returns author-specified preferred layer for this pin
**getPrefLayerPropName**()
returns name of property used to specify preferred routing layer for this pin
**getShapes**()
returns list of the shapes which are currently associated with this pin
**getTerm**()
returns the terminal associated with this pin
**getTopLayer**()
returns the top Layer on which this pin has associated geometries
**removeShape**(Shape *shapes*)
**removeShape**(ulist[Shapes] *shapes*)
removes the shape(s) from this pin
**setAccessDir**(Direction | ulist[Direction] *dir*)
sets access direction(s) for this pin (viewed from Instance containing this pin)
**setAuthorPrefLayer**(Layer *layer*)
sets layer to be author-specified preferred layer for routing purposes
**setName**(string *name*)
sets the name for this pin
**setTerm**(Term *term*)
associates terminal with pin; multiple pins may be associated with single terminal.

**Attribute:**

**name** – the name of this pin (settable attribute)

**Term**

Represents the logical connection points within a design. A terminal is logically associated with a net to export connectivity to the next higher-level in the design, and is associated with one or more pins, which represent physical connection points.

**Term**(string *termName*, TermType *termType*=TermType.INPUT_OUTPUT)
creates new terminal in the current design; if there is already a net in the current design having the same name as this terminal, then the net will be connected to this terminal. Otherwise, a new net will be created, and connected to this terminal.

**destroy**()
destroys this terminal, first destroying any pins owned by this terminal

**find**(*name*='')
returns the terminal having this name in the current DloGen design

**getMustJoinTerms**()
returns list of all terminals which are in the "must-join" set of this terminal

**getName**()
returns the name for this terminal

**getNet**()
returns the net associated with this terminal object

**getPins**()
returns list of all pins associated with this terminal

**getTermType**()
returns the terminal type value assigned for this terminal

**setMustJoin**(Term *term*=None)
marks this terminal as requiring connection at an upper level of design hierarchy; if *term* parameter is None, then terminal will not be marked for connection.

**setName**(string *name*)
sets the name for this terminal; the name of any associated net for this terminal will also be changed, ensuring that nets and terminals will have the same name.

**setNetOverride** (string *assignmentName*, string *netName*)
creates an oaTermConnectDef associating this single-bit terminal with the oaAssignment named *assignmentName*. If the oaAssignment referred to does not exist, this single-bit terminal is associated with the net named *netName*. An exception is thrown if the net named *netName* does not exist.

**setTermType**(TermType *termType*)
sets the terminal type value for this terminal

**Attributes:**

**name** – the name of this terminal (settable attribute)
**type** – the terminal type for this terminal (settable attribute)
**AttrType** – display attribute type for this terminal

## InstTerm

The InstTerm class is used to represent the connection between a net and a terminal of the master of an instance in the design. These instance terminals will automatically be created, whenever an instance is created within a design.

**find**(string *name*, Instance *inst*)
returns the instance terminal having this name in the current DloGen design

**findInstPin**(string *name*="")
returns instance pin having this name for this instance terminal
**getInst**()
returns the Instance object associated with this instance terminal
**getInstPins**()
returns list of all of the InstPin objects for this instance terminal
**getMustJoinInstTerms**()
returns list of all InstTerm objects which must be joined together
**getNet**()
returns the net associated with this instance terminal
**getTermName**()
returns the name for this instance terminal
**setNet**(Net *net*)
adds this instance terminal to the specified net; if the *net* parameter is None, then this instance terminal is removed from any net to which it is connected.

**Attributes:**

**termName** – the name of this instance terminal
**AttrType** – display attribute type for this instance terminal

**InstPin**

The InstPin class is used to represent a mapping of the pin in the instance master into the current coordinate system. Since this InstPin object is simply a mapping, these InstPin objects are read-only, and created whenever an instance is created in the current design. Note that there is not any OpenAccess equivalent object for this InstPin class object.

**find**(string *name*, Instance *inst*)
**find**(string *name*, InstTerm *instTerm*)
returns the instance pin having this name in the current DloGen design; these instance pins are obtained from the *inst* Instance or the *instTerm* InstTerm object.
**getAuthorPrefLayer**()
returns author-specified preferred layer for routing purposes for the corresponding pin in the instance submaster.
**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns the bounding box fpor the corresponding pin in the instance submaster, for all layers on which this pin has associated geometries.
**getInst**()
returns the instance for this instance pin
**getInstTerm**()
returns the instance terminal for this instance pin
**getLayers**(LayerList *layers*=None)
returns list of layers on which the corresponding pin in the instance submaster has associated geometries.

**getNet**()
returns the net for this instance pin
**getPinAccessDir**()
returns the access direction(s) for the corresponding pin in the instance submaster
**getPinName**()
returns the pin name for this instance pin
**getPrefLayer**()
returns author-specified preferred layer for routing purposes for the corresponding pin in the instance submaster; if there is no preferred layer, the top layer is used.
**getShapeRefs**(ShapeFilter *filter*=ShapeFilter())
returns list of shape references for all shapes which are associated with the corresponding pin in the instance submaster.
**getTermName**()
returns the name of the terminal for this instance pin
**getTopLayer**()
returns the top layer on which the corresponding pin in the instance submaster has associated geometries, as defined by the layer number in the Technology file.

**Attribute:**
**pinName** – the pin name for this instance pin

**RouteTarget**

Class used by the RoutePath class to specify shapes which should be connected by a route path; represents a target to "route from" or "route to" by RoutePath methods. RouteTarget object consists of one or more route boxes, along with associated layers. Note that any Rect, RectRef, Pin or InstPin objects will automatically be converted to appropriate RouteTarget object.

**RouteTarget**(Rect *rect*, Point *point*=None)
**RouteTarget**(RectRef *rectRef*, Point *point*=None)
**RouteTarget**(InstPin *instPin*, Point *point*=None)
**RouteTarget**(Pin *pin*, Point *point*=None)
**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns bounding box for the route boxes contained in this RouteTarget
**getChosenAccessDir**()
returns access direction which was chosen for this RouteTarget
**getChosenAccessPoint**()
returns access point which was chosen (or specified) for this RouteTarget
**getChosenBox**()
returns box for chosen shape for this RouteTarget
**getChosenLayer**()
returns layer on which the chosen route box is defined for this RouteTarget
**getLayers**()
returns list of layers on which any route boxes are defined
**getName**()
returns name generated for this RouteTarget

**getPrefLayer**()
returns name of any preferred layer
**getRoutePathIntersectBox**()
returns box which is intersection of route box and RoutePath
**getRoutePathLayer**()
returns layer which will be used by the associated RoutePath
**hasLayer**(Layer *layer*)
returns True if RouteTarget has a route box on specified layer
**isSingleBox**()
returns True if RouteTarget has a single route box
**isValid**()
returns True if RouteTarget is valid
**needsContact**()
returns True if RouteTarget requires contact to be generated

## Topology

Provides class used to store a string used to describe basic topological configuration for a parameterized cell design object.

**Topology**(string *topology*)
creates Topology object using specified topology string
**getName**()
returns string value for this Topology object
**setName**(string *name*)
sets string value for this Topology object

# VI. UTILITY CLASSES

Basic classes provided to facilitate various parameterized cell design creation tasks. These tasks include specification of parameters, handling of parameter values, user-defined properties for different design objects, handling lists of points, generation of unique names and log file management. These classes include the ParamArray, ParamSpecArray, PropSet, PointList, Log and Unique classes.

**ParamArray**

Stores different parameters and their values for a parameterized cell design. Class objects can be used much like built-in Python dictionary.

**ParamArray**()
**ParamArray**(**kwds)
creates ParamArray object; if keywords are used, must be of form “name=value”
**add**(*name, value*)
**add**(*name = value*)
adds a parameter and its value to this ParamArray
**get**(string *name*)
returns value for parameter with specified name; if no parameter, exception raised
**has_key**(string *name*)
returns True if there is a parameter of this name in this ParamArray
**iteritems**()
returns iterator for parameter and value pairs (items) in this ParamArray
**iterkeys**()
returns iterator for parameters (keys) in this ParamArray
**itervalues**()
returns iterator for values (values) in this ParamArray
**remove**(string *name*)
removes parameter and its value from this ParamArray
**reset**()
resets this ParamArray, by removing all parameters and values
**set**(*name, value*)
**set**(*name = value*)
sets value for parameter to given value; parameter will be added, if does not exist
**setFromSpecs**(ParamSpecArray *specs*)
copies all parameters from the *specs* ParamSpecArray
**update**(ParamArray *params*)
updates all parameters using values from *params* ParamArray; if parameter already exists, its value will be updated, otherwise parameter and its value will be added.

**ParamSpecArray**

Stores different parameter specifications for a parameterized cell design. Class objects can be used much like built-in Python dictionary.

**add**(*name, value, docString*=None, *constraint*=None)
adds parameter and its specification to this ParamSpecArray
**has_key**(string *name*)
returns True if there is a parameter of this name in this ParamSpecArray
**iteritems**()
returns iterator for parameters and specifications (items) in this ParamSpecArray
**iterkeys**()
returns iterator for all of the parameters (keys) in this ParamSpecArray
**itervalues**()
returns iterator for all of the specifications (values) in this ParamSpecArray
**remove**(string *name*)
removes named parameter and its specification from this ParamSpecArray
**verify**(ParamArray *params*)
verifies parameters in ParamArray, using specifications from this ParamSpecArray

**Attribute:**
**tech** – returns technology object used when ParamSpecArray was created

**ViaParam**

Stores parameter values to create a standard via, using pre-defined parameter names. Class objects can be used much like built-in Python dictionary.

**ViaParam**(ViaParam *params* = None, ulist[Coord] *layer1Ext*=None,
ulist[Coord] *layer2Ext*=None, ulist[Coord] *implant1Ext*=None,
ulist[Coord] *implant2Ext*=None, ulist[Coord] *layer1Offset*=None,
ulist[Coord] *layer2Offset*=None, ulist[Coord] *originOffset*=None,
ulist[Coord] *cutSpace*=None, ulist[Coord] *cutSize*=None,
Layer *cutLayer*=None, ulist[int] *NumHVCuts*=None)
creates ViaParam object, using the specified parameter values; if *params* is specified, then ViaParam object obtains its values from *params* object.
**hasDefault**(string *paramName*)
returns True if *paramName* is set to its default value, and returns False otherwise
**items**( )
returns list of all parameters and values (items) defined for this ViaParam
**iteritems**( )
returns iterator for parameters and values (items) in this ViaParam
**keys**( )
returns list of all parameters (keys) defined for this ViaParam
**iterkeys**()
returns iterator for all of the parameters (keys) in this ViaParam

**setDefault**(string *paramName*)
sets value for *paramName* parameter to its default value

**Attributes:**

**cutLayer** – cut layer for the standard via
**cutSize** – via cut sizes used by the standard via
**cutSpace** – spacing values between via cuts for the standard via
**implant1Ext** – enclosure values for implant layer over bottom layer (layer1)
**implant2Ext** – enclosure values for implant layer over top layer (layer2)
**layer1Ext** – enclosure values for bottom layer (layer1) over the cut layer
**layer1Offset** – x and y offset values for bottom layer (layer1) enclosure rectangle
**layer2Ext** – enclosure values for top layer (layer2) over the cut layer
**layer2Offset** – x and y offset values for the top layer (layer2) enclosure rectangle
**numHVCuts** – number of horizontal and vertical cuts for the standard via
**originOffset** – offset in x and y coordinates from the origin for the standard via

## PropSet

Provides storage for user-defined properties which have been defined for a given design object. Such properties can be defined and associated with the DloGen, PhysicalComponent and Lib class objects (or any objects derived from these classes, except for the Grouping class and objects derived from the Grouping class).

**clear**()
clears this PropSet, by removing all property definitions
**empty**()
returns True if this PropSet is empty
**get**(string *name*, object *defaultVal*=None)
returns value for property with given name; if no property exists, default value used
**getProp**(string *name*)
returns value for property with given name; if no property exists, exception raised
**has_key**(string *name*)
**items**()
returns list of property name and value pairs (items) in this PropSet
**iteritems**()
returns iterator for property name and value pairs (items) in this PropSet
**iterkeys**()
returns iterator for property names (keys) in this PropSet
**itervalues**()
returns iterator for property values (values) in this PropSet
**keys**()
returns list of property names (keys) in this PropSet
**update**(PropSet *other*)
updates this PropSet, by adding all of the property names (keys) and property values (values) contained in *other* PropSet; this operation may overwrite existing property names and property values in this PropSet.

**values**()
returns list of property values (values) in this PropSet

**PointList**

Class used to define and operate on lists of points. These PointList class objects are typically used with the various Shape class creation methods, such as the Polygon or Path class creation methods, as well as the MultiPath creation method.

**PointList**(ulist[Point]=None)
creates PointList object using the specified list of points
**addOffsets**(Coord *begin*=0, Coord *end*=0)
adds *begin* offset to first point and *end* offset to last point in this PointList object
**compress**(Bool *isClosed*=True)
compresses this PointList object, by removing any coincident or collinear points
**containsPoint**(Point *point*, Bool *incEdges*=True)
returns True if *point* is contained inside point list shape, and False otherwise
**copy**()
returns copy of this list of points
**deepcopy**()
returns deep copy of this list of points
**genJustifyPoints**(Direction *justify*, Coord *sep*)
returns justified point list constructed from this PointList object
**getArea**()
returns area enclosed by point list shape. Note this area value will be positive for counter-clockwise point ordering, negative for clockwise ordering, zero otherwise.
**getBBox**()
returns bounding box for this list of points
**hasExtraPoints**(Bool *isClosed*=True)
returns True if the points in this list contains any coincident or collinear points
**isOrthogonal**(Bool *isClosed*=True)
returns True if the points in this list are orthogonal, otherwise False
**isSelfIntersecting**(Bool *isClosed*=True)
returns True if point list shape is self-intersecting, and False otherwise.
**mirrorX**(Coord *xCoord*=0)
mirrors all points around the X-coordinate axis
**mirrorY**(Coord *yCoord*=0)
mirrors all points around the Y-coordinate axis
**moveBy**(Coord *dx*, Coord *dy*)
moves all points by the specified x and y coordinate values
**moveTo**(Point *destination*, Location *handle*=Location.CENTER_CENTER)
moves all points so that the specified *destination* point becomes the *handle* point for the bounding box which contains these points.
**moveTowards**(Direction *dir*, Coord *distance*)
moves all points in the specified direction by the specified distance

**onEdge**(Point *point*, Bool *isClosed*=True)
returns True if *point* is on edge of point list shape, and False otherwise
**rotate90**(Point *origin*=None)
rotates all points 90 degrees, in a counter-clockwise direction
**rotate180**(Point *origin*=None)
rotates all points 180 degrees, in a counter-clockwise direction
**rotate270**(Point *origin*=None)
rotates all points 270 degrees, in a counter-clockwise direction
**transform**(Transform *trans*)
applies the specified transform to all points

## Log

Class used to write information to the various logging files maintained by the Santana design system, such as errors, warnings, general information, debug and test data.

**debug**(string *msg*)
writes specified message string to the debug log file
**error**(string *msg*)
writes specified message string to the error log file
**info**(string *msg*)
writes specified message string to the info log file
**test**(string *msg*)
writes specified message string to the test log file
**warning**(string *msg*)
writes specified message string to the warning log file

## Unique

Generates unique name for name within the name space of a given design object. The generated name is guaranteed to be unique within a single design, provided that this class is used to generate all names for design objects within the current design.

**Name**(string *baseName*)
returns unique name, based upon the specified base name (defaults to “CNI_”)

### NameMapper

Class used to map names for instances or nets when the **clone**() method is used. This name mapping can be defined using a suffix-prefix string having the general form "subPrefix/addPrefix:subSuffix/addSuffix", a Python dictionary, or a general Python callback function. This name mapping object can then be passed as an optional parameter to the **clone**() method

**map**(string *name*)
method used to perform name mapping, returns the mapped name

### SnapType

Defines snap types which can be used with Grid object or physical components. SnapType.CEIL, SnapType.FLOOR, SnapType.ROUND, SnapType.TRUNC and SnapType.ROUND_CEIL used for SnapType.**ceil**(), SnapType.**floor**(), SnapType.**round**(), SnapType.**trunc**() and SnapType.**round_ceil**().

**snap**(*self*, Coord *size*, Coord *val*)
performs snap operation using *self* snapping type
**ceil**(Coord *size*, Coord *val*)
performs snap operation, using CEIL ceiling rounding convention
**floor**(Coord *size*, Coord *val*)
performs snap operation, using FLOOR floor rounding convention
**round**(Coord *size*, Coord *val*)
performs snap operation, using ROUND round rounding convention
**round_ceil**(Coord *size*, Coord *val*)
performs snap operation, using ROUND_CEIL rounding convention
**trunc**(Coord *size*, Coord *val*)
performs snap operation, using TRUNC truncation rounding convention

### Grid

Abstract representation of the manufacturing grid used to manufacture integrated circuits. User can specify Grid sizes for both X and Y coordinate values.

**Grid**(Coord *xSize*, Coord *ySize*=None, SnapType *snapType*=SnapType.CEIL)
creates Grid object, based upon specified sizes and snap type
**getSize**()
returns size or resolution value
**getSnapType**()
returns snap type defined for this Grid object

**getXSize**()
returns X-coordinate size or resolution value
**getYSize**()
returns Y-coordinate size or resolution value
**setSize**(Coord *size*)
sets size or resolution value for this Grid object
**setSnapType**(SnapType *snapType*)
sets the snap type for this Grid object
**setXSize**(Coord *size*)
sets X-coordinate size or resolution value for this Grid object
**setYSize**(Coord *size*)
sets Y-coordinate size or resolution value for this Grid object
**snap**(Coord *val*, SnapType *snapType*=None, unsigned int *mult*=1)
returns "snapped to" grid coordinate value, based upon snap type
**snapX**(Coord *val*, SnapType *snapType*=None, unsigned int *mult*=1)
returns "snapped to" X-coordinate value, based upon snap type
**snapY**(Coord *val*, SnapType *snapType*=None, unsigned int *mult*=1)
returns "snapped to" Y-coordinate value, based upon snap type

**Numeric**

The Numeric class is used to create a floating point number from a string representation (such as "10ns"), using a floating point number along with a pre-defined scaling factor. These pre-defined scaling factors are one of the following:

| Character | Name | Multiplier |
|---|---|---|
| Y | Yotta | 1e24 |
| Z | Zetta | 1e21 |
| E | Exa | 1e18 |
| P | Peta | 1e15 |
| T | Tera | 1e12 |
| G | Giga | 1e09 |
| M | Mega | 1e06 |
| K or k | Kilo | 1e03 |
| '' | No Scale Factor | 1.0 |
| % | percent | 1e-2 |
| c | centi | 1e-2 |
| m | milli | 1e-3 |
| u | micro | 1e-6 |
| n | nano | 1e-9 |
| p | pico | 1e-12 |
| f | femto | 1e-15 |
| a | atto | 1e-18 |
| z | zepto | 1e-21 |
| y | yocto | 1e-24 |

Since this Numeric class is derived from the base Python float class, it can be used just

like a regular floating point number in any numerical computation.

**Numeric**(float | int | string)
creates Numeric object, using specified number or string value; the string value must be a number followed by one of the pre-defined scaling factors.
**scaleFormat**(string *scaleFactor*=None)
returns floating point number formatted using specified *scaleFactor* scaling value

**Attributes:**
**scaleFactor** – original scale factor used when Numeric object created
**scale_factors** – list of all available scaling factors, along with their values

**cFloat**

The cFloat class is used to create a single precision floating point number, which has the same precision as a C/C++ "float" type floating-point number. This class can be used with parameterized cells which were originally developed in SKILL and use parameters with single precision floating point numbers.

**cFloat**(float)
creates a cFloat object, based upon the specified floating point number

**AttrDict**

The AttrDict class is used to create a Python dictionary in which the elements of the dictionary can directly be accessed through the use of attribute syntax. For example, instead of using "dict[key]" to access dictionary values, "dict.key" can be used instead.

**AttrDict**([arg])
Creates an AttrDict dictionary object, based upon the specified keys and values. Keys and values can be specified using positional arguments or a set of keyword arguments, such as "AttrDict(a=1, b=2)" or "AttrDict([['a',1], ['b',2]])".
**clear**()
removes all items from this attribute dictionary
**get**(*k*, *d*=None)
returns value for specified *key*; if key is not found, returns specified *default* value
**has_key**(*k*)
returns True if *k* is a key in this attribute dictionary, and False otherwise
**items**()
returns all of the key/value pairs defined for this attribute dictionary
**iteritems**()
returns iterator for all of the key/value pairs in this attribute dictionary
**iterkeys**()
returns iterator for all of the keys in this attribute dictionary

**itervalues**()
returns iterator for all of the values in this attribute dictionary
**keys**()
returns all of the keys defined for this attribute dictionary
**pop**(*k*, [*default*])
removes specified key *k* from dictionary, and its corresponding value is returned; if key *k* does not exist, then an exception will be raised.
**popitem**()
removes and returns an arbitrary key/value pair from this attribute dictionary; can be used to destructively iterate over dictionary, and remove its items one by one.
**setdefault**(*k*, [*default*])
if specified key *k* exists, then return its value; if key *k* is not in dictionary, then insert *key* into dictionary. If *default* is specified, then it is used as the value for key *k*; otherwise, the value for key *k* is set to None.
**update**(*E*)
updates this dictionary with all key/value pairs from the specified dictionary *E*
**values**()
returns all of the values defined for this attribute dictionary

**OrderedDict**

The OrderedDict class is used to create a Python dictionary in which the elements of the dictionary are kept ordered according to the order in which the keys were specified.

**OrderedDict**(*init_val*=(), *strict*=False) – creates an OrderedDict dictionary object, based upon the specified *init_val* initial value ordered list of key and value pairs.
**clear**()
removes all items from this ordered dictionary
**copy**()
returns a copy of this ordered dictionary
**index**(*key*)
returns position of the specified *key* in this ordered dictionary.
**insert**(*index, key, value*)
sets specified *value* for specified *key* at specified position *index* in this dictionary
**items**()
returns list of tuplesrepresenting all key/value pairs for this ordered dictionary
**iteritems**()
returns iterator for all of the key/value pairs in this ordered dictionary
**iterkeys**()
returns iterator for all of the keys in this ordered dictionary
**itervalues**()
returns iterator for all of the values in this ordered dictionary
**keys**()
returns all of the keys defined for this attribute dictionary

**pop**(*key*, **args*)
removes specified *key* from dictionary, and its corresponding value is returned; if *key* does not exist, then an exception will be raised.

**popitem**(*i* = -1)
removes and returns specified key/value pair from this attribute dictionary; can be used to destructively iterate over dictionary, and remove its items one by one.

**rename**(*old_key*, *new_key*)
renames key, without modifying sequence order for this ordered dictionary

**reverse**()
reverses sequence order for all items in this ordered dictionary

**setdefault**(*key*, *defval*=None)
if specified *key* exists, then return its value; if *key* is not in dictionary, then insert *key* into dictionary. If *defval* is specified, then it is used as the value for *key*; otherwise, the value for *key* is set to None.

**setitems**(*items*)
uses specified *items* to set all of the items for this ordered dictionary

**setkeys**(*keys*)
uses specified *keys* to replace all of the keys for this ordered dictionary

**setvalues**(*values*)
uses specified *values* to replace all of the values for this ordered dictionary

**sort**(**args*, ***kwargs*)
sorts key order for this ordered dictionary, same as Python list **sort**() method

**update**(*from_od*)
updates ordered dictionary with key/value pairs from specified ordered dictionary

**values**()
returns list of all values defined for this ordered dictionary

### ParamDictSpec

The ParamDictSpec class is used to specify parameters and specifications for these parameters. This is done by creating an ordered Python dictionary in which the keys are the parameter names, and the values are the specifications for these parameters.

**ParamDictSpec**()
ParamDictSpec derives from OrderedDict base class, so uses same creation method

**match**(data)
checks that parameter and value matches parameter specification

**optional**(*key*, *datatype*, *doc*=None, *constraint*=None)
adds optional parameter and specification to this ParamDictSpec object

**required**(*key*, *datatype*, *doc*=None, *constraint*=None)
adds required parameter and specification to this ParamDictSpec object

**CDF**

The CDF class is used to read CDF data which is stored as a property on a cell. This CDF data is returned using an AttrDict attribute dictionary; all CDF data can then be accessed using standard attribute syntax. Note that there is no need to use a creation method, since this CDF data is already being stored as a property on the cell.

**forCell**(string *libName*, string *cellName*)
returns stored CDF data for this cell, using an attribute dictionary; this allows all CDF data to be accessed using standard attribute syntax.

**DPL**

The DPL class is used to convert a SKILL Disembodied Property List into an AttrDict attribute dictionary. This allows SKILL data which is stored using disembodied property lists to be more easily accessed using a Python dictionary. Note that this class only contains a creation method, since once the attribute dictionary is created, the DPL data can be directly accessed.

**DPL**([arg])
returns data for the SKILL disembodied property list, using an attribute dictionary; this allows all DPL data to be accessed using standard attribute syntax.

**Fill**

The Fill class is used to fill a physical component with patterns of either rectangles or instance array objects. The filling methods in this Fill class are "smart" methods which make use of the Santana "Geometry Engine" to perform the polygon filling operations, so that they will make use of the relevant design rules in the associated technology file.

**fillPhysCompWithInstArrays**(PhysicalComponent *comp*, Layer *encLayer*,
Layer *layer*, InstanceArray *instArray*,
Coord *layerExt*=None, Point *origin*=None,
Grouping *group*=None)

Fills *comp* physical component with *instArray* instance array.

**fillPhysCompWithLargeArraysOfInstArrays**(PhysicalComponent *comp*,
Layer *encLayer*, Layer *layer*,
Coord *arraySpaceX*,
Coord *arraySpaceY*,
InstanceArray *instArray*,
Coord *layerExt*=None,
Point *origin*=None,
Grouping *group*=None)

Fills *comp* physical component with a large array of instance arrays; the *arraySpaceX* and *arraySpaceY* values specify spacing between instance arrays.

**fillPhysCompWithLargeArrayOfRects**(PhysicalComponent *comp*,
Layer *encLayer*, Layer *layer*,
Coord *arraySpaceX*, Coord *arraySpaceY*,
unsigned *numRows*, unsigned *numCols*,
Coord *width*=None, Coord *height*=None,
Coord *spaceX*=None, Coord *spaceY*=None,
Coord *layerExt*=None, Point *origin*=None,
Grouping *group*=None)

Fills *comp* physical component with large array of rectangles. The *numRows* and *numCols* values specify dimensions of this array of rectangles, while *arraySpaceX* and *arraySpaceY* values specify spacing between rectangles in the array.

**fillPhysCompWithRects**(PhysicalComponent *comp*, Layer *encLayer*,
Layer *layer*, Coord *width*=None, Coord *height*=None,
Coord *spaceX*=None, Coord *spaceY*=None,
Coord *layerExt*=None, Point *origin*=None,
Grouping *group*=None)

Fills *comp* physical component with equally sized and spaced rectangles

**CrossOver**

The CrossOver class computes the minimum 45 degree X cross-over of two parallel paths, which may have different widths. This **CrossOver** class provides methods to generate the polygons which cross over and connect each of these two parallel paths. These 45 degree X cross-overs will be computed based upon the widths of the two parallel paths, as well as the spacing between them.

**CrossOver**(Coord *width1*, Coord *space*, Coord *width2*=None,
Grid *grid*=None, Coord *space45*=None, Coord *width45*=None)
creates minimum 45 degree X cross-over between two parallel paths, based upon specified widths of the two paths, as well as the spacing between them.

**genPath1Polygon**(Direction *dir*, Direction *justify*, Point *innerPoint*, Layer *layer*)
generates polygon for cross-over points returned by **getPath1Points**() method

**genPath2Polygon**(Direction *dir*, Direction *justify*, Point *innerPoint*, Layer *layer*)
generates polygon for cross-over points returned by **getPath2Points**() method

**getDistance**()
returns minimum distance needed to create 45 degree X cross-over obtained by connecting parallel paths on one side of the cross-over to the other side.

**getPath1Extends**()
returns list of two cross-over extensions for first path

**getPath1Points**(Direction *dir*, Direction *justify*, Point *innerPoint*)
returns list of two point lists for cross-over points for first path; first point list is list of points for inner edge points, while second is list of points for outer edge.

**getPath2Extends**()
returns list of two cross-over extensions for second path

**getPath2Points**(Direction *dir*, Direction *justify*, Point *innerPoint*)
returns list of two point lists for cross-over points for second path; first point list is list of points for the inner edge points, while second is list of points for outer edge.

**getSpace**()
returns spacing value between first path and second path

**getWidth1**()
returns width of first path

**getWidth2**()
returns width of second path

**getWidth45**()
returns actual diagonal width value, which is scaled by the square root of two

**set**(Coord *width1*, Coord *space*, Coord *width2*=None,
Grid *grid*=None, Coord *space45*=None, Coord *width45*=None)
changes dimensions of **CrossOver** object, using specified parameter values; parameter values are exactly the same as parameter values in creation method.

**Attributes:**

**distance** – minimum distance required to create cross-over
**path1Extends** – list of cross-over extensions for first path
**path2Extends** – list of cross-over extensions for second path
**width45** – actual diagonal width value

## Marker

The Marker class indicates design violations and the objects causing these design violations in the OpenAccess database. The location of the design violation is represented using a list of points assigned to the marker. In addition, a message string which describes the design violation can be attached to the marker, along with the objects which caused the design violation. The name of the tool which reported the design violation, along with the severity level for the design violation can also be assigned to the marker.

**Marker**(ulist[Point] *points*, string *msg*="Error marker",
string *shortMsg*="Error marker", string *tool*="*PyCell*",
Bool *isVisible*=True, Bool *isClosed*=True,
MarkerSeverity *severity*=MarkerSeverity.FATAL_ERROR)
creates a Marker object, based upon specified points for the location of the design violation, strings for error messages and tool, as well as marker severity level.

**addObject**(PhysicalComponent | BlockObject | ulist[PhysicalComponent] |
ulist[BlockObject] *obj*)
adds specified physical component(s) or BlockObject(s) to this marker

**clone**()
returns a cloned copy of this Marker object

**getBBox**(ShapeFilter *filter*=ShapeFilter())
returns bounding box for this marker

**getMsg**()
returns message string describing design violation for this marker

**getObjects**()
returns list of objects causing design violations associated with this marker

**getPoints**()
returns list of points for area or location of the design error for this marker

**getSeverity**()
returns severity level of design violation for marker, using pre-defined values: ANNOTATION, INFO, ACKNOWLEDGED_WARNING, WARNING, SIGNED_OFF_ERROR, ERROR, SIGNED_OFF_CRITICAL_ERROR, CRITICAL_ERROR or FATAL_ERROR.

**getShortMsg**()
returns short message string associated with this marker

**getTool**()
returns name of tool reporting design violation for this marker

**isClosed**()
returns True if list of points for this marker is closed; returns False, otherwise
**isVisible**()
returns True if this marker should be visible; returns False, otherwise
**removeObject**(PhysicalComponent | BlockObject | ulist[PhysicalComponent] | ulist[BlockObject] *obj*)
removes specified physical component(s) or BlockObject(s) from this marker
**setIsClosed**(bool *val*)
indicates whether the list of points for this marker is closed or not
**setIsVisible**(bool *val*)
indicates whether this marker should be visible or not.
**setMsg**(string *msg*)
sets message string describing design violation for this marker
**setPoints**(ulist[Point])
sets list of points which specifies area or location of design error for this marker
**setSeverity**(MarkerSeverity)
sets severity level of design violation for this marker, using pre-defined values: ANNOTATION, INFO, ACKNOWLEDGED_WARNING, WARNING, SIGNED_OFF_ERROR, ERROR, SIGNED_OFF_CRITICAL_ERROR, CRITICAL_ERROR or FATAL_ERROR.
**setShortMsg**(string *msg*)
sets short message string to be associated with this marker.
**setTool**(string *msg*)
sets name of tool reporting design violation for this marker

**DrcSummary**

The DrcSummary class is used to obtain information about the results of running the design rule checking program, using the DloGen "**fgDrc**()" method.

**checkedRules**()
returns number of design rules which were checked; this number is calculated after reduction of the design rules in the DRC rule deck has taken place.
**errorNumber**(string *ruleName*)
returns number of errors generated for specific named design rule
**getRuleList**()
returns list of names of all design rules which failed; these design rule name strings can then be used with the "**errorNumber**()" method.
**totalErrorNumber**()
returns total numbers of design rule errors found for the current design

## Global Functions

**fgDrc**(Dlo *dlo*, DrcSettings *drcSettings*=None)

Runs the design rule checking program on the specified *dlo* design object. The returned value is the *drcSummary* utility class object which can be used to query the results of running design rule checking; methods are provided to determine the number of errors, the number of design rules checked, etc. The *drcSettings* default parameter is only provided for future enhancements; it is not necessary to use this parameter, as the default will automatically be used when calling this function. This function uses all of the design rules in the Santana technology file attached to the specified *dlo* design object, as is done when running the DRC program through the graphical environment.

**stretchHandle**(Shape *shape*, string *name*, string *parameter*, Location *location*,
Direction *direction*, string *display* = "", float *minVal*=0.0,
float *maxVal* = 10000.0, string *stretchType* = "relative",
string *userSnap* = "0.005", string *userScale* = "1.0")

Assigns graphical stretch handle to shape in the generated PyCell layout. The *shape* parameter is the actual shape object; the *name* parameter is a unique name for the stretch handle, while *parameter* is the name of the PyCell parameter being modified by the user. Note that this *shape* parameter can also be an instance or the current design object; for an instance, the *name* parameter should be the name of the instance and for the current design object, the *name* parameter will be ignored. The *location* parameter specifies which location on the *shape* bounding box should be used to attach the stretch handle, while the *direction* parameter specifies the stretching directions (NORTH_SOUTH or EAST_WEST). The *minVal* and *maxVal* parameters are the minimum and maximum values for the PyCell parameter. The *stretchType* parameter is either "relative" or "absolute" and specifies how the stretched distance should be measured. The *userSnap* parameter is the resolution value used for snapping parameter values, while the *userScale* is the scale factor used to multiply the change in PyCell parameter value. The optional *display* parameter can be used to display a specified text string on the Text layer at the location of the stretch handle location point.

```
stretchHandleCustom(Shape shape,
                    string name,
                    string parameter,
                    Location location,
                    Direction direction,
                    string display = "",
                    **kwargs)
```

Assigns graphical stretch handle to shape in the generated PyCell layout. The *shape* parameter is the actual shape object; the *name* parameter is a unique name for this stretch handle, while *parameter* is the name of the PyCell parameter being modified by the user. Note that this *shape* parameter can also be an instance or the current design object; for an instance, the *name* parameter should be the name of the instance and for the current design object, the *name* parameter will be ignored. The *location* parameter specifies which location on the bounding box for the shape should be used to attach the stretch handle, while the *direction* parameter specifies the directions in which the shape may be stretched (NORTH_SOUTH or EAST_WEST). The optional *display* parameter can be used to display a specified text string on the Text layer at the location of the stretch handle location point. This **stretchHandleCustom**() function simply copies any optional keyword arguments and values which may be specified, and then appends them to the *pycStretch* string property which is associated with the shape in the PCell layout. It is then left for the EDA tool application to interpret these additional keyword arguments and values and perform any indicated operations.

**autoAbutment**(Shape *shape*, float *pinSize*, ulist[Direction] *directions*, string *abutClass*,
list *abut2PinBigger*, list *abut3PinBigger*,
list *abut2PinEqual*, list *abut3PinEqual*,
list *abut2PinSmaller*, list *abut3PinSmaller*,
list *noAbut*, string *function* = “”)

Defines auto-abutment properties for a PyCell and attaches them to shapes in the generated layout. The *shape* parameter is the pin shape object which can be abutted, while the *pinSize* specifies the width of this pin shape. The *directions* parameter specifies the list of directions in which this pin shape may be abutted, while the *abutClass* parameter is a string which identifies the abutment class. The next seven parameters specify values for different types of abutment conditions, using a fixed format. These abutment conditions are categorized by the number of pin shapes which are connected to the same net (either 2 or 3 devices connected to the same net), as well as the relative size of the pin shapes which are being abutted. The final optional *function* parameter specifies the name of any external abutment function which should be called. Note this function will set all required pin shape auto-abutment properties, except for *pycShapeName*; this property should instead be set using the Shape **setName**() method for the pin shape.